SCHOOL SCIENCE AND MATHEMATICS

Vol. LI | December, 1951 | Whole No. 452

PEACE AND GOODWILL

A. N. Tucker

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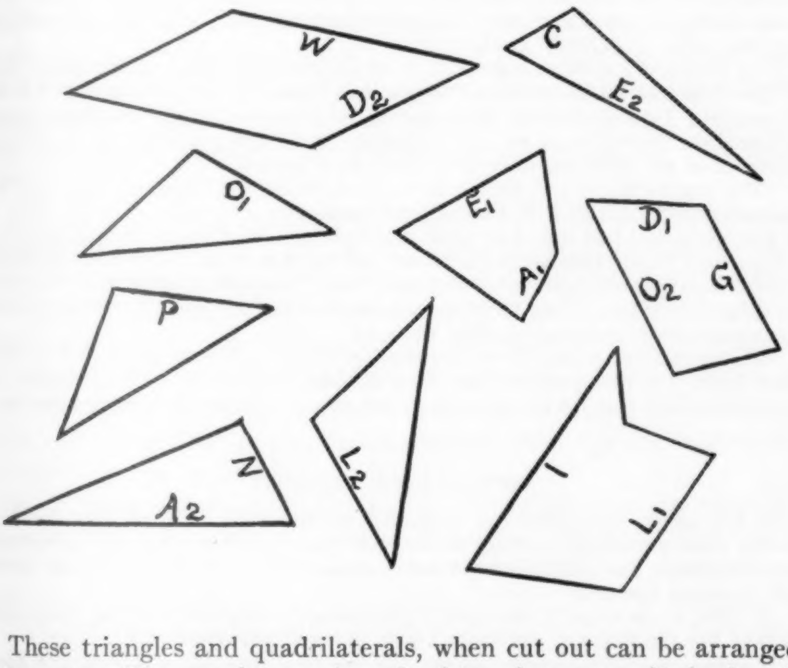
The five pointed star is a symbol of "Peace on Earth, Goodwill to Men."



These triangles and quadrilaterals, when cut out can be arranged into a star. The puzzle may be solved by chance, or, if the key is discerned, falls into place. To solve it, you have to think about it, to work on it, and to want to do it.

Peace and goodwill, whether within families or among nations, are

not easily come by. Like its prototype in the puzzle, it may be stumbled upon, or, if the underlying causes and conditions are comprehended and acted upon, it may come as a natural consequence. You have to think about it, to work for it, and to want it to come to pass.

BW NEGLECTED IN RESEARCH, BACTERIOLOGIST HEAD CHARGES

The government is not spending nearly enough on finding out ways to combat biological warfare to which, in terms of sabotage, we would be much more vulnerable than to the A-bomb.

This is the charge of Dr. Walter J. Nungester, president of the Society of American Bacteriologists. In addition, he told Science Service, too much information which might be useful in protecting ourselves against BW attacks is still being held in secrecy.

"It is not a classified secret," Dr. Nungester said, that there is now no adequate vaccine for brucellosis and tularemia, two diseases which might be used in BW. Yet adequate funds have not been made available to do the work to find and produce an adequate vaccine.

"You cannot bring an A-bomb into this country in your vest pocket," he went on. "Yet it is possible to bring the right cultures inside our borders in small amounts and then an enemy agent could cook up his own home brew of disease almost as was done with real home brew back in prohibition days."

Dr. Nungester said that any "beginning bacteriologist" with the right culture and the right "cookbook" could do the job.

The University of Michigan medical school professor declared that something of the same kind of effort should be put into preparing defenses against BW as is put into A-bomb defense. More funds for research and development, more information disseminated to bacteriologists, and more publicity as to the importance of the problem, were three steps he suggested.

"The enemy might not hit us with the A-bomb, the expected weapon," he pointed out, "but with BW, the surprise weapon."

Dr. Nungester had sent a letter to the Federal Civil Defense Administration, with a copy to the Defense Department, asking that more information be made available to bacteriologists and that more funds be spent on research.

"The answer from Civil Defense was satisfactory," he said, "but they do not have much more information than we have."

He also received a letter from Secretary of Defense Robert A. Lovett stating that funds for this purpose had been doubled. However, Dr. Nungester did not believe this was yet an amount which would adequately meet the problem.

SCIENTISTS NEEDED

In ten years, the number of scientists employed by industry has doubled. In the same period the number of scientists and engineers employed in defense establishments has multiplied ten times. And in the next ten years, the trend will continue upward.

In 1950, there were 75,000 college graduates in scientific fields, in 1951, only 47,000. For the next ten years, the trend will continue downward.

It is the considered opinion of most people that this nation can defend itself from Communist aggression only by maintaining a great technological superiority over the Soviet Union and its satellites. This technological superiority must be based on the knowledge and findings of an ever-increasing number of scientists and engineers. Therefore, everything which promotes the idea of science among young people promotes this nation's defense.

SOUND FUN WITH THE OSCILLOSCOPE

ROBERT L. PRICE
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In the early twenties, Dayton Clarence Miller published his book, *The Science of Musical Sounds*,[1] and it became possible for student and layman to "see" sounds both simple and complex. The book made real the analysis and synthesis of waves in general, and sounds in particular. Physics teachers found this book invaluable not only because of the information of historical interest which it contained, but because the presentation was that of a great teacher.

As an accomplished musician, Miller appreciated music and musical tones, and in his discussion of the quality of tones from the instruments he studied, he quoted from Sidney Lanier's great poem, The Symphony. Both poet and physicist were talented flutists.

Lecturers in physics formerly used the manometric flame or some similar device to show pressure variations in sound waves, and some sort of kymograph to show the vibration of tuning forks or the vibration of a stylus actuated by the sound waves themselves. Miller's phonodeik which is described in many physics books, replaced the stylus by a vibrating mirror and a beam of light which reflected from the mirror and traced the motion on a moving film. The instrument responded to a great range of frequencies and its perfection gave us the remarkable photographic records so widely used in textbooks today.

Shortly after the appearance of Miller's book, one of my colleagues obtained permission to make lantern slides of the illustrations which visualized the simplest tone such as that of the flute blown softly, the complex tones of several instruments, and the tones of the human voice. The slides made it possible for the audience at a community lecture to see the tones of familiar instruments, and to understand why the same tone played on different instruments sounded differently, and how it was possible for them to pick out the various instruments in an ensemble.

Some years ago when the first *cathode ray oscilloscope* was obtained for our demonstration equipment, the first uses made of the instrument were the usual electrical demonstrations. When a *crystal microphone* was procured, we were delighted to find that it would give satisfactory waves for sound sources when directly connected to the vertical input of the oscilloscope, without the aid of an amplifier. Since then we have been able to show most of the wave forms so thoroughly investigated by Miller. For better teaching, not all are

[1] Dayton C. Miller, *The Science of Musical Sounds*, The Macmillan Company, 1922.

shown at one time, but the equipment is made available for several classes by mounting it on a cart which can be moved from one classroom to another. Of course, the larger the screen, the more suitable is the oscilloscope for class demonstrations.

Simple waves can be shown by striking a mounted tuning fork or bar with a soft mallet, and holding the opening of the resonator near the microphone. A tone and its octave can be compared by the number of waves on the screen. The major chord can best be shown by adjusting the oscilloscope so that four waves are seen for the first tone, whereupon the succeeding tones will show five, six, and eight waves.

The relationship between pitch and frequency can be demonstrated effectively with a glass tube type of whistle equipped with a piston. The length of the tube can be changed quickly, causing variations in pitch to appear on the screen as a changing number of waves.

Rapid variations can be obtained by use of the laboratory type of siren when definite frequencies are desired or by means of the toy siren whistle which accelerates when blown and produces a variable frequency.

Amplitude can be studied in its relation to the energy used in producing the sound, much as voltages are compared on the screen. A fork struck with a metallic object will show the "clang-tone" which exhibits small amplitude, high frequency waves superposed on the basic wave.

Interference of sound from identical sources is usually shown in high school classes by having the student rotate a tuning fork on its axis, near the ear. The four regions of reenforcement and of destructive interference due to waves from the two tines of the fork can also be shown by rotation of the fork near the microphone. A similar use of the microphone might be made for resonant tube effects but, in general, these are heard fairly well by the students in a moderately-sized classroom without the use of an amplifier.

Another type of interference is that of two tones quite close on the musical scale, which when sounded together show a remarkable beat-tone picture. A little experimentation with striking adjacent bars of high frequency on a chimes set or toy xylophone will yield stable beat patterns which show the rise and fall in amplitude associated with beats. Even a toy whistle with two tubes, which gives a shrill sound when blown, shows the effect well.

The oscilloscope makes the study of quality and wave-form meaningful. An initial study can be made with the mounted forks; a tone and its octave sounded simultaneously will give a complex wave which is readily explained by wave addition. Sounds of large amplitude which can be sustained for class observation can best be ob-

tained with organ pipes of wood or metal, by placing the microphone near the lip of the pipe. Playing an organ pipe first as an open tube, and then as a closed tube, shows that the fundamental in the former case is an octave higher than that in the second case.

Comparison of the tones from an organ pipe when the pipe is blown softly, moderately or hard, illustrates the dependence of quality upon the relative intensities of the fundamental and overtones. The exploration of sound quality can be carried much farther when music students bring instruments and recordings to play. The microphone may be placed near the speaker of a record player and the music picked up directly. A portable reed organ in our department makes possible the study of individual tones and combinations. Study of the voice has been limited to the basic sounds. Students are impressed with the similarity of vowel sounds produced by different individuals.

Miller introduced the study of instruments by analyzing tones from the flute, which when blown softly gave simple waves. An increase in intensity introduced the octave, and a more complex pattern resulted. He went on to study the violin, clarinet, oboe, horn, and piano. To show a highly complex wave, he used the music of the famous Sextette from "Lucia di Lammermoor," which combined six voices with orchestral accompaniment.

Overtones from strings can be picked up directly by placing the microphone near the openings on the sides or ends of the resonating box of the sonometer. Touching the vibrating string at the center or some other point, which breaks the string into vibrating segments of equal length, will cause the string to give off tones in the harmonic series. Although weak, they are sustained enough to be heard in a quiet room, and to be seen on the oscilloscope screen.

The usefulness of the cathode ray oscilloscope and crystal microphone in demonstrating sound phenomena is greatly increased by the addition of an *amplifier and speaker*, and an *audio frequency oscillator*.

Since the range of frequencies of tuning forks and bars found in the physics laboratory seldom extends from 100 to 1000 v.p.s., demonstrations have been limited. The limits of audibility were formerly shown with a series of steel bars struck with a metal hammer. The sound of the hammer striking the metal often masked the tone listened for. With the oscillator[2] and amplifier, the range of tones is from 20 to 20,000 v.p.s. which is a rough measure of the limits of audible sounds. Demonstrations with this arrangement are often a feature of the assembly programs sponsored by telephone companies.

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[2] The audio frequency oscillator, the amplifier, and speaker can be obtained commercially or they can be constructed from kits, also available commercially, at less than half the cost.

With a little practice, the teacher can reproduce the tones of the scale through two or three octaves, and can play the major and minor triads in different octaves. Again, suitable adjustment of the oscilloscope shows the tones of the major chord as four, five, six, and eight waves on the screen.

Beat phenomena are quickly and forcibly shown by blending the sounds from a 440 bar and the amplifier when the oscillator is set near 440 v.p.s. The frequency of the oscillator can be adjusted above or below that of the bar so that the number of beats per second can be varied at will.

Interference of high frequency waves which have traveled different distances can be detected by use of the microphone and amplifier, as suggested by Richardson and Cahoon.[3] An arrangement of two paths is made with two T-tubes and pieces of rubber tubing, one path of which can be varied by sliding one of the pieces of rubber tubing on a length of glass tubing. In our set-up a small telephone receiver connected to the audio oscillator is satisfactory as a source when used at about 3000 v.p.s. Small funnels attached to the openings are used to introduce the sound at one opening and to pick up the resultant sound at the other. Individual observation is desirable and the one funnel can be used as a receiver for the ear. Placing the microphone at the receiving funnel makes possible the amplification of the sound received only if the sound source is sufficiently muffled. Adjustment of the variable path produces maxima and minima which are observable in this manner.

The usual classroom demonstration of the reflection of sound consists of holding a watch at the focus of a spherical or parabolic mirror and turning the system so that the reflected sound is directed toward students in each part of the room. If a sensitive flame is placed at the focus of one mirror, the sound made by jangling keys, or by blowing a Galton whistle, at the focus of a second mirror perfectly aligned with the first, causes the flame to vibrate. Since neither of these is highly successful, an adaptation of the latter demonstration utilizing the apparatus under discussion here is suggested. A small telephone receiver connected to the audio oscillator is placed at the focus of the first mirror and acts as a source of high frequency waves. A microphone at the focus of the second mirror is connected to the amplifier and makes the reflected wave audible.

One of the most beautiful oscilloscope demonstrations made possible by the audio oscillator is that of Lissajou's Figures. The combination of two vibrations at right angles is produced by connecting the oscillator and a 60 cycle A.C. source to the vertical and hori-

[3] Richardson and Cahoon, *Methods and Materials for Teaching General and Physical Science*, p. 322. McGraw-Hill Book Company Inc. 1951.

zontal input posts respectively, as directed in the detailed instructions for the particular oscilloscope used. Figures can be obtained for multiples and sub-multiples of the 60 cycles per second. Simple adjustment of the oscillator gives figures for the ratios usually illustrated in college textbooks and oscilloscope manuals. The ratios can be identified quickly by counting the vertical and horizontal loops. The demonstration is simplified as compared to older methods using light reflected from mirrors on tuning fork prongs set at right angles, or the many ingenious devices using pendulums of different lengths. Easy visibility and a wide range of ratios make this set-up especially valuable.

While it is possible to pick up the overtones from a string mounted on a good sonometer by means of the crystal microphone, or the microphone in connection with an amplifier, a method suggested by R. C. Grubbs uses the equipment under discussion in a very successful manner.[4] A wire of non-magnetic material is mounted on a sounding board, and the ends of the wire are connected to the low voltage side of a six volt transformer. The high side is connected to the amplifier. An alnico magnet is placed at the center of the string so that when the string is vibrated, the induced voltages are stepped up and appear on the screen as waves, while the sound is heard on the speaker. Proper adjustment gives a single wave when the fundamental is present.

Use of two magnets placed at one-fourth and three-fourths the length of the string, with their polarities alternated, produces the first overtone when the string is plucked, and two waves are observed on the screen. The tone is heard easily due to the amplification. Touching the string at its center is not essential since it damps the vibration too much. By properly spacing and alternating the polarities of the magnets, the harmonic series can be beautifully demonstrated. While the initial sound following the plucking of the string will be complex, patience will be rewarded when clear waves of the number corresponding to the harmonic under study appear on the screen, and these will persist long enough for the student to observe them.

At Joliet Township High School, these demonstrations are supplemented with sound motion pictures dealing with *The Cathode Ray Oscilloscope*, *Sound Waves and Their Sources*, and *The Symphony*. It seems reasonable that our students should have the experiences which these pieces of equipment make possible in the study of sound, in addition to those in the fields of electricity and radio. We believe that they should be acquainted with modern apparatus as many of them may later find themselves using such apparatus in technical

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[4] R. C. Grubbs, "Demonstrations in High School Physics," School Science and Mathematics, Vol. 48, No. 3, p. 200. March 1948.

work in civilian life or in the armed services. In the meantime, these demonstrations have stimulated their interest and improved their understanding of some phenomena of sound.

THE EQUATION OF THE PARABOLA

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One of my freshman students, Leslie Cochran, has turned up the following interesting property of the equation of the parabola.

The equation of a parabola with vertex at the origin and principal axis coinciding with the x axis is

$$y^2=2px.$$

The equation of a parabola in this position passing through a given point may be written at once by using the abscissa of the point for the coefficient of y^2 and the square of the ordinate for the coefficient of x.

Thus the equation of the parabola in this position passing through the point (2, 5) is

$$2y^2=25x.$$

The equation of the parabola passing through the point $(-4, -3)$ is

$$-4y^2=9x.$$

Likewise, the equation of the parabola of the form $x^2=2py$ may be written using the ordinate as the coefficient of x^2 and the square of the abscissa as the coefficient of y. Thus the equation of the parabola in this position passing through the point $(-2, 3)$ is

$$3x^2=4y.$$

The proof follows. To find the equation of the parabola of the form $y^2=2px$ passing through the point (a, b), substitute the co-ordinates of the point into the equation and solve for p. Thus

$$p=b^2/2a$$

and the equation of the parabola then is $y^2=(b^2/a)x$ or

$$ay^2=b^2x.$$

The proof for the parabola of the form $x^2=2py$ is similar.

SCHOOL LUNCH AND NUTRITION EDUCATION

Prepared by the Interdivisional Committee on Nutrition Education and School Lunch of the Office of Education. Office of Education Bulletin 1951, No. 14. 12 pages. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 10 cents.

This new bulletin answers briefly 21 questions which deal with the relation of the school lunch to nutrition education, health aspects of the school lunch, and certain administrative and financial matters. It is intended to be helpful to schools that are considering, for the first time, the setting up of a school lunch program, and for others who may be desirous of improving their present procedures. Some questions answered are "What part of the child's food needs should be met by the school lunch program?" "How should school lunch personnel be selected and trained?" and "How are school lunch programs financed?"

DIMENSIONS AND UNITS

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Students studying mathematics and science often are unable to determine the unit of the answer to a problem. This is especially true if the solution is obtained by use of a formula. The scientist uses the language of mathematics as a means of expressing his quantative ideas. He is greatly concerned with the units involved in his mathematical processes.

Fortunate is the student who has had good instructors and who has been taught the importance of developing the unit along with the numerical answer. "Only like things can be added" is one of the first rules in arithmetic the child learns. Each of the fundamental operations is so closely related to the process of addition so this accepted idea is really a part of all the fundamental operations.

The child learns to add three books and four books. Later he learns the abstract addition of three and four. Multiplication is introduced as a short method of addition if all addends are equal. 3×4 books is given the meaning 4 books+4 books+4 books. The product can be found by addition. When this is understood the pupil knows the multiplicand may be either concrete or abstract but the multiplier must be abstract. The purpose of the multiplier is to tell the number of times the multiplicand (addend) is used.

If the pupil understands the process of multiplication he sees that 3 feet$\times$4 feet$=$12 square feet is not an acceptable expression from the point of view of the definition of multiplication. (The writer of this paper recently observed a class in elementary arithmetic in their study of multiplication. Near the end of the class period the teacher wrote this question on the board, "What is the cost of 6 pencils at 5 cents each?" A pupil went to the board and wrote "6 pencils$\times$5 cents$=$30 cents." The teacher accepted this!)

Sometimes the instruction of arithmetic is of such a nature that the pupil is led into abstract mathematics with little training in concrete concepts. Abstract mathematics is introduced to some pupils before they are ready for it. Arithmetic developed from physical experiences and the child should learn to count physical objects.

If the pupil understands the meaning of multiplication he can be taught division. Division is the inverse of multiplication. If the pupil sees that 3×4 books$=$12 books he can understand that division is twofold in nature.

$$12 \text{ books} \div 4 \text{ books} = 3 \text{ or}$$
$$12 \text{ books} \div 3 = 4 \text{ books}$$

By carrying the unit each time a fundamental operation is performed the child learns the beginning of the methods used to determine the unit of the numerical answer. A student who has not had this training may not see the sense in what is done when a person works a problem and gives a unit to the answer.

A student who learns the definition of division as the inverse of multiplication may question the attempt to divide 90 miles by 3 hours. The definition of division does not seem to apply. Many of the so-called divisions are ratios. The abstract numbers may be divided. 90 miles ÷ 3 hours is a ratio and gives the result 30 miles per hour. The unit, miles per hour, is a ratio of a distance to a time. Many of the units in mathematics are ratios of this nature.

All physical units may be expressed in terms of three fundamental concepts. Elementary physics textbooks give good explanations of this. These are length (L), mass (M), and time (T). The student who has learned to analyze the formula by a study of dimensions (L, M, and T) has acquired a valuable tool for understanding the formula and its unit.

If the postulate that only like things can be added is recalled, the student has little difficulty seeing that in any formula each term involved must have the same dimensions.

In the well-known formula $S=V_0t+\frac{1}{2}\ at^2$, S is the distance or displacement, V_0 the original velocity, a is the acceleration and t is the time. Since the left term S has the dimension of a length (L) it follows each of the two terms on the right of the equality also has the dimension L.

Velocity is a distance ÷ time (a ratio) or L/T.

Acceleration is a velocity ÷ time or $(L/T) \div T$ or L/T^2.

The dimension of each term then is

$$L=\frac{L}{T}\ (T)+\frac{1}{2}\cdot\frac{L}{T^2}\ (T^2), \qquad L=L+\frac{1}{2}\ L.$$

This is saying "this length = a length + another length."

A basic test for the validity of a formula is: "In a formula or mathematical statement of equality all terms have the same dimensions." This is a necessary condition for any formula.

Training in expressing units in dimensional form assists the students in detecting errors in formulas. The volume of any object has the dimensions of L^3. If the formula for the volume of a sphere is copied $4/3\pi r^2$ the student should see the formula is not correct—the dimensions are not right. An area has the dimensions L^2. The area of the surface of a sphere is proportional to the square of the radius. $A=kr^2$ the value of the k is 4π and the formula is $A=4\pi r^2$.

Better understanding of units involved in the problem is obtained by carrying units with the numerical value and treating the units as though the postulates of the fundamental operations apply. This is common practice in the laboratory.

A student may ask, "What are the units of wave length?"

Velocity ÷ frequency = wave length.

Velocity is length ÷ time.

Frequency is vibrations per unit of time.

$$\text{Wave length} = \frac{\dfrac{\text{length}}{\text{time}}}{\dfrac{\text{vibrations}}{\text{time}}} = \text{length per vibration.}$$

A second example illustrates the use of this principle in a problem.

A ball is shot upward with an initial velocity of 192 feet per second. Where is the ball after 9 seconds? (Neglect friction and assume acceleration due to gravity is 32 feet per second per second downward.)

The formula used is $S = V_0t + \frac{1}{2}\,at^2$ where $V_0 = 192$ feet per second, t is 9 seconds and $a = -32$ feet per second per second.

$$S = 192\ \frac{\text{feet}}{\text{seconds}}\ 9\ \frac{\text{seconds}}{1} - \frac{1}{2}\ 32\ \frac{\text{feet}}{\text{seconds}^2}\ 9^2\ \text{seconds}^2$$

$$= 1728\ (\text{feet}) - 1296\ (\text{feet})$$

$$S = 432\ \text{feet.}$$

Each term gives the unit feet. The answer is interpreted as meaning 432 feet above the starting point.

Students can learn the fundamental concepts of units and dimensions in a short period of time. The knowledge gained serves the student in his problem solving and makes meaningful many formulas that are so much a part of mathematics and science.

ARE YOU WRITING A TEXTBOOK?

There is no one ideal style. The good writer is full of his subject matter. He sees into it and all around it and can view it in perspective. He is aware of his audience: a specific group, with known background and with definite limitations, whom he had an overwhelming desire to reach and enlighten. He is sufficiently at ease to be himself and flavor his writing with his own personality. Such a man, with the aid and advice of a publisher, should produce something worthwhile.

E. D. Hamilton, *President*
John Wiley & Sons, Inc.

THE SPECIMEN'S SPECTACULAR STAIRWAY

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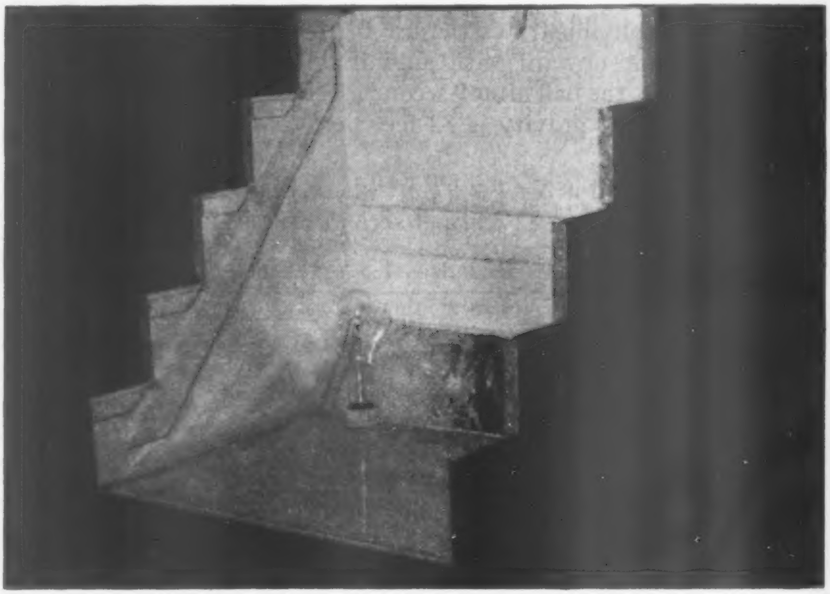
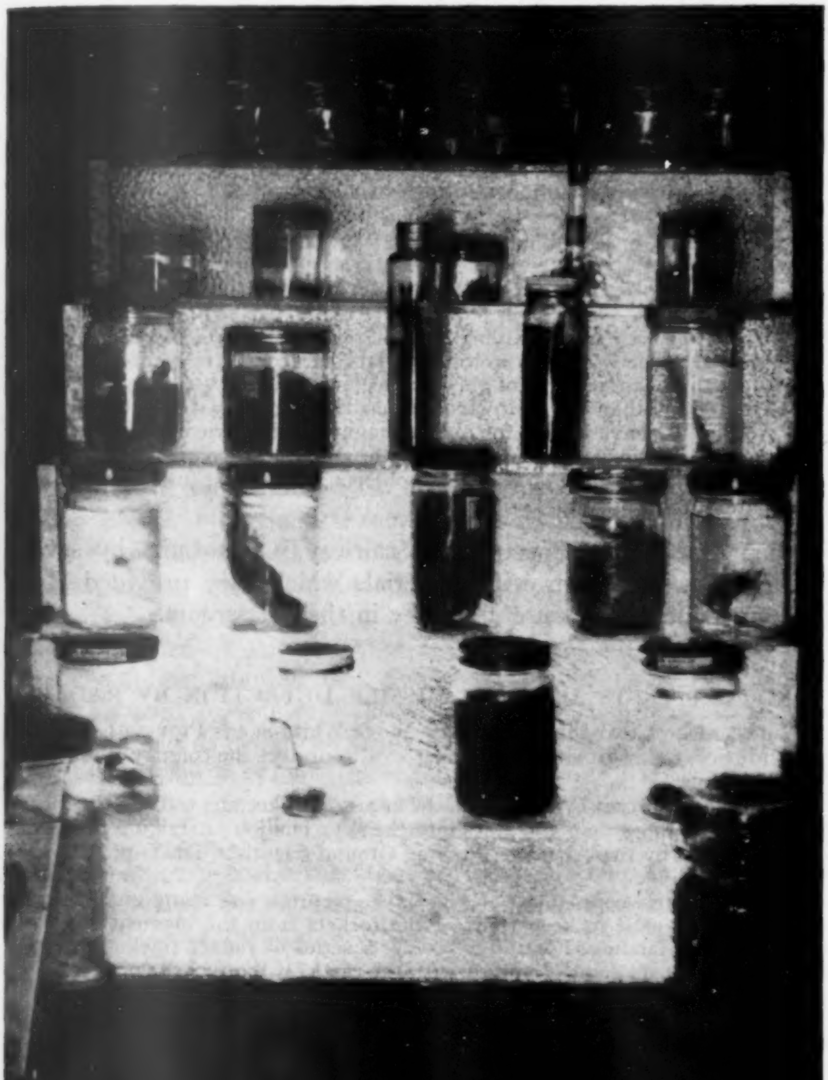
Biology teachers everywhere have their cherished collection of preserved specimens. Some are preserved in alcohol, some in formalin solutions. Most of these preserved specimens are in glass jars, either glass-topped museum jars or screw-topped specimen jars. That these specimens have their value in teaching will not be challenged. It would almost appear that no biology teacher would be without them. Yet they have their shortcomings as a teaching aid. They break; they spill their contents; the specimens become detached or change positions; and they sometimes are not as illustrative as they were



hoped to be. Most of these deficiencies are the direct result of the practice of allowing students to handle jars which lack suitable display space that will show them to advantage.

The author has been perplexed with these problems and has found what he believes to be a good solution. A device has been constructed by the students which seems to solve all the problems of the use of preserved specimens. It has been called "The Specimen's Spectacular Stairway." It is essentially a short stairway of five steps; the stair treads and backs are of plain and frosted plate glass respectively. There are two, one hundred and fifty watt bulbs mounted below the stairs, and mirrors direct all the light rays upward through the glass

of the stairs. The stairs are two feet wide with a five inch step and tread. If the average size specimen jar is used, twenty five to thirty jars of specimens can be displayed on this stairway. The light which passes through the clear plate glass of the treads and the frosted glass



of the backs of the stairs passes through the preserved solution which surrounds the specimens and illuminates the specimens very brightly, in fact, far more brightly than they can be lighted in any other part

of the normal classroom. Magnifying glasses are hung on the side of the stairway on three convenient hooks. The observer can easily enlarge his views of the specimen to obtain greater detail.

There are many effective uses of the "Specimen's Spectacular Stairway." In our experience it has been found that:

1. No specimens have been broken, spilled, or damaged.
2. No specimens have been detached from mountings.
3. No labels have been removed. (Since the specimens are in the best possible light and position for examination, moving them becomes unnecessary.)
4. Students examine all specimens in far greater detail. (They were easier to find, to see, and to examine.)
5. Time is saved in handling. (No specimen is ever passed about the class any more.)
6. The beauty of the brilliantly lighted "Specimen's Spectacular Stairway," has a phototropic effect on the students, and like moths, they gather about it and carefully examine these beautifully displayed, centrally located specimens.
7. There has been a great saving in display area. It is possible, using this device, to perfectly display up to thirty jars of average size in careful order on a desk, top surface area of only two feet square.
8. Items other than liquids in jars can be advantageously displayed using this device. We have used it for plastic mounts, slides, dried specimens, living specimens (aquatic specimens in jars or aquarium), colored chemical solutions, small metallic objects, glass objects, and almost innumerable transparent items of suitable size.

Our "Specimen's Spectacular Stairway," was built by several students, as a project, with materials which they provided. They take great pride in its useful beauty in their classroom.

ROCKET TESTS ADVANCE MISSILE DETECTION BY RADAR

As test rockets roar through the sky above White Sands Proving Grounds in New Mexico, radar experts are learning how to protect the country from enemy guided missiles.

This is an important by-product of the necessity of keeping track of the rockets as they travel more than 100 miles into the sky. The job of stalking the guided missiles is told by two Aberdeen Proving Ground scientists, Dr. Dirk Reuyl and L. G. de Bey.

All kinds of telescopes, most of which take pictures, and many kinds of radar equipment are used to keep track of the rockets from the moment of takeoff until the final landing. For safety's sake, a series of radars tracks the rocket and can predict its point of impact with the earth. If the rocket is straying outside of the range, it can be exploded in the air before it lands.

Although it was not stated in the article, it does not take much imagination to visualize a little additional equipment designed to pick up an enemy rocket. It can then be tracked with great precision with some of the equipment now in use at the White Sands Proving Grounds.

Window pane holder, a recently patented device to replace the putty ordinarily used to hold the glass in the sash, is a metallic strip having a body portion of V-shaped cross section which fits into a slot in the sash. Rubber behind the strips makes a tight joint.

MORE DOUBLE TALK

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Norman Lowenstein performs a noteworthy service to education in general and to the teaching of Biology in particular, in his article "Biological Double Talk" which appeared in the January 1951 issue of School Science and Mathematics. The tendency of teachers to accept terminology merely because of its tradition and common usage makes a mockery of scientific method, especially among those trained in science. It seems to be an almost universal truism that reexamination is a necessary concomitant of progress and of the development and revision of knowledge. I agree with Mr. Lowenstein that every teacher has probably encountered some of this "Double Talk" which plays havoc with logical exposition. Some of the ideas which have annoyed me, follow.

Adaptation

Whereas we avoid teleological explanations in preference to some version of the mutations theory in describing evolution and the development of new characteristics, we retain a word with passive connotations to describe these characteristics. An animal is said to have an adaptation for defense or for food getting; and the unwary student very easily falls into the semantic trap which translates it into "the animal adapted itself by developing claws or a long neck." Once this idea of self motivated adaptation is appreciated by a biology teacher as being the probable result of his teaching, he must eliminate it from his biological vocabulary.

Cause and Effect

It is very easy to be sure that soft bones result from a lack of vitamin D. However, a little research proves that they may also result from a lack of vitamin C, or calcium, or phosphorus, or parathormone. What, then, is the cause of soft bones or, for that matter, of any disease? Consideration leads to the conclusion that most effects are the results of more than one cause or prerequisite factor. This doctrine of multiplicity of cause has long been treated in textbooks on logic. Yet the idea has not penetrated the more common books on science, where cause and effect are treated as a hallowed sine qua non to be worshiped by all. The influence of psychological conditions, hormones, vitamins, antibiotics, amino acids, antibodies, and trace elements on "resistance" makes it impossible to state categorically that the presence of a certain bacillus will cause a certain disease. Our thinking, as well as that of our students in social and political

fields, would benefit greatly if we were to emphasize the possible existence of more than one cause or factor for any effect or event which is observed. This is a fallacy not only of science teaching, but of all teaching and thinking in general.

Immortality of Amoeba

This idea is often mentioned in relation to the teaching of binary fission. Its implication is that an amoeba cannot die. Yet any student can observe an amoeba dividing once into two, and two into four, and see them all die before his eyes. The fact that a sister of the first amoeba mentioned may still be alive, or that it may continue to live through its offspring does not in any way disprove the fact that the amoeba being observed was definitely mortal. I object to the use of the word immortal here as I would to its use in describing a man or any other animal. The idea that part of an organism is passed on to the next generation, or that genes are able to reproduce themselves, requires a description quite other than that of immortality.

Osmosis

It is confusing to student and teacher alike to encounter the word "concentration" used in one book to describe the relative amount of solute, while in another, it refers to the solvent. The chemically trained person uses the word with reference to the solute and uniformity in this connection would certainly be helpful.

Furthermore, there is never given an answer to the question "What is the limit of the height to which a liquid will be pushed as the result of osmosis and of osmotic pressure?" It becomes necessary to describe the semi-permeable membrane statistically for solute as well as solvent. Some of the solute usually diffuses through the membrane in any experiment.

Protoplasm

The idea is as tenuous as the substance usually described as viscous, jelly-like, and translucent. In the first place let it be made clear that the substance is not homogeneous, nor is it of constant composition. Therefore the same substance is not found in all living cells. Therefore protoplasm is a very general term, and cannot be specifically defined. It is about time the writers and teachers broke away from the common oversimplification which is certainly far from the true facts.

Refraction in the Eye

The part played by the cornea and the aqueous humor in refracting light before the beam enters the lens is completely ignored in second-

ary school treatments of the subject. Yet, the aforementioned window of the eye, with its aqueous humor, has an index of refraction of one and one third, while that of the lens is one and forty four hundredths. Thus, light is bent as it enters the cornea, as it enters the lens, and as it leaves the lens, three times in all.

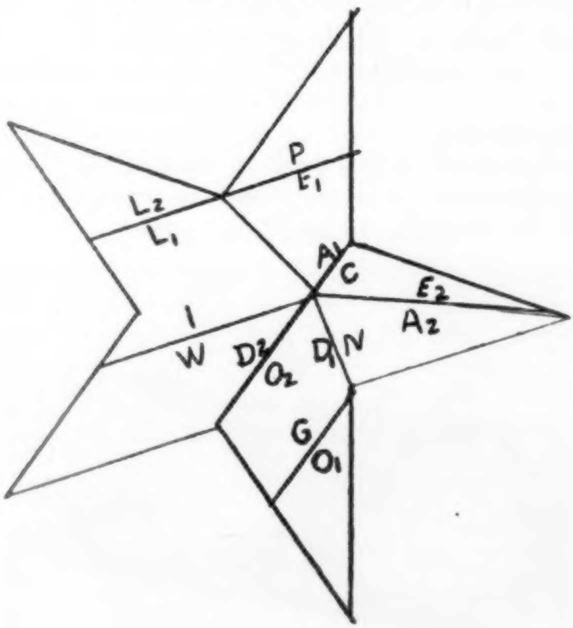
There are many details and general considerations such as these which have escaped the attention of textbook writers, and consequently may be unknown to those teachers whose duties and interests prevent them from searching the literature, and from contemplating the forest as well as the trees.

KEY TO *PEACE AND GOODWILL*

(*See page 681*)

You will observe that the title is the key. Because of repetition, subscripts for the first and second letters have been used. Thus, putting the polygons together with E_1 following next to P, A_1 followed by C and E_2 next in line, the pieces are readily sorted.

$PE_1A_1CE_2$ A_2ND_1 $GO_1O_2D_2$ WIL_1L_2



Christmas lamp shade, usable on any table electric lamp, replaces the ordinary shade and looks like a small fir tree. Shaped like a 16-inch high cone, it is colored in shades of green, and even has sturdy projecting twigs and branches on which Christmas tree ornaments may be hung.

CAVALIERI'S THEOREM

Frank Hawthorne
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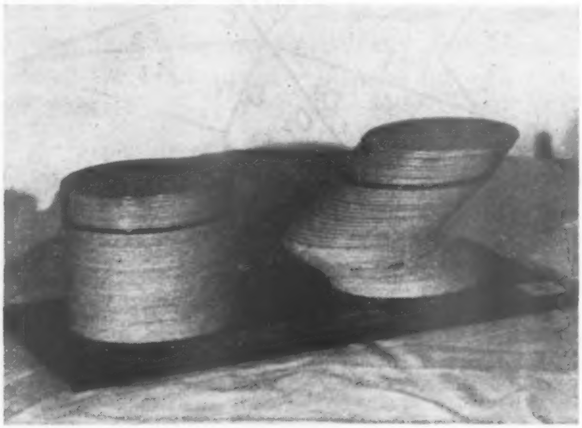
In the study of Solid Geometry, Cavalieri's theorem is frequently assumed and used to prove (or at least to make reasonable) many of the familiar formulas for volumes. Some students seem to have difficulty in visualizing this theorem. The model shown in the photograph is designed to aid them.

The two equal solids are made from beer coasters cemented together and mounted on a masonite base. Immediately after the coasters have been cemented a board should be placed over the top of the two piles and weights so distributed on the board that the heights of the piles are equal. It is not convenient to weight the skew pile separately. The edges of one pair of corresponding coasters should be painted a contrasting color before assembly to illustrate more vividly a particular pair of sections.

The top coaster is turned with the advertising downward and the teacher is at liberty to call the elements disks of cardboard if he wishes. Of course, equal pieces could be cut from cardboard but the prepared coasters (which can usually be obtained free) are uniform and quite satisfactory.

The model shown is of two solids in which all horizontal sections are equal circles. Some breweries distribute coasters of other shapes which could, undoubtedly, be used to advantage.



Rain hat, umbrella-size and made of a plastic sheeting, is an inflatable affair held extended by a tire-like tube around the rim which is blown up by mouth when the owner gets caught in a storm. When collapsed, it folds to a cigarette-size package, easily carried in a handbag.

MAKING SCIENCE LIVE FOR THE CHILD*

SISTER M. AQUINAS
Manitowoc, Wisconsin

Before launching my subject I shall make a few remarks by way of introduction. The word, child, in my talk, refers to child in the elementary grades. All references are to the work in which I am now engaged. All conclusions I draw are from actual experience with a very large number of children in the elementary school.

We do not need to make science live for the child—it already lives for him. In my wide experience with children I have not found any who prefer the indoors to the outdoors. What we must do, however, is to teach science in such a way that the situation in the classroom is alive; that the child's enthusiasm is matched by the teacher's; that an attempt is made to answer the child's questions; that the child develops deeper understandings of the workings of nature. We need to progress beyond the phase where the teacher admits that children know more about science than the teacher. Teachers must definitely challenge, stimulate, and *lead* in the science classroom. Teachers must remember this when they are preparing for their profession, and schools that train teachers must more adequately cover this phase of teacher training.

Science teaching must be different from teaching in other subjects. Some courses can be taught on a reading basis, but the background for thinking in science must be laid through visual aids, experiment, observation—in other words, with some type of activity in which the children are taken out to nature, or nature is brought into the classroom. Reading is the *last phase* of the learning process in science. We want children to read—but not before they *can* read, that is, not before a science vocabulary has been built, and the vocabulary cannot be built until the child has formed ideas in his mind.

We must build reading skills in science like we do it in a regular reading class, that is, stimulate the formation of ideas through activity and conversation, then use the words and phrases on the blackboard, on flash cards, on reading charts. Scientific ideas translated into words make those words intelligible and meaningful on the printed page. We read for enrichment and for stimulation to further discovery *after* basic concepts in an area of science are understood.

With the building of a science vocabulary through the realization of meanings of scientific terms, the wonderful world of science reading becomes a part of the child's life. He comes into his heritage of

* Read at the Elementary School Group Meeting of the Annual Convention of the C.A.S.M.T., November 25, 1950.

science literature. Children are excited by the marvelously pictorial and colorful books which painstaking science educators have prepared for them on every grade level.

I had an interesting experience in Green Bay when we began our science program a little more than two years ago. I visited the libraries of the Valley to see what was there for science enrichment. Librarians were delighted to hear that schools were launching a science course that would prepare children for reading science books. The libraries had acquired many of them on every grade level. As I went through the shelves I found that most of these books had not been taken out for a period of two years. I was told the books were too difficult for the children.

There has been a great change. Today those books and hundreds of additional titles are very popular with the children. It is indeed difficult to provide sufficient science reading for the libraries and bookmobiles serving northeastern Wisconsin, although budgets have been stretched to the limit to fill this new need of young readers. Besides books, libraries are providing filmstrips for use of schools in science (also in other subjects). There is no aid, except it be the sound film, that helps teachers to teach, and pupils to learn science like the filmstrip. After the basic activity is done, the filmstrip, or sound film, on the lesson is an incomparable aid to the assimilation of concepts. So much for reading in science.

Let me introduce the second objective in science by stating a problem. Is the learning of science concepts to be the *whole* of the science course? I heard a speaker from the University of Wisconsin say something like this at an organizational meeting for science teachers: "We want to teach more than science in our 13-year integrated science program. We want the scientist to be a more useful member of the community. We want the scientist to be more mindful of his social responsibility. We want the scientist to make a better world, not to destroy the world."

I take my cue from the gentleman for the next five minutes of my talk. If an elementary science course were to give only science concepts, it would fall quite short of the needs of the child. If that were to be the sole capacity of the course, it were better that it be skipped. The world might last longer if we *omit* making a million more scientific planners of destruction.

Realization of social responsibility *must* be one of the main objectives in our science teaching. Social responsibility is a broad term. Almost *all* responsibility is social. Our interpretation of responsibility is tied up with obligation, and is therefore seated in one's character. All teachers *know* that character training is the *main* objective in setting up *every* course. Virtues of the person are the integrating fac-

tors in our educational reorganization program. The President's Committee calls it "Education for Life Adjustment."

The training of good, loyal, responsible citizens—youth who ***know*** they are the future of this, the best country on the face of the earth, is the aim of our science program. These youths must have ***faith*** in America, loyalty to America, and the American way. How can *faith* in America be stimulated in a child? "To thine own self be ***true***, and it must follow, as night the day, thou canst not ***then*** be false to any man." Therein lies the ***true*** way of making better men to usher in better times. Character training is the key objective of all education.

Character training is developing one's self ***truly***, and ***fully***, that is, economically, morally, physically, culturally and socially—to make the highest degree of social adjustment to life. That's a "large order" for one's self—yet it must be served if one is to be true to self, so as to be true to fellowman. We believe social responsibility is developed by *living* our obligations in three life relationships—relationship to God, to fellowman, to nature. All three are bound together. As we build in ourselves awareness to responsibilities in these three areas of experience, we develop our material and spiritual skills, our own selves. We build our own character—positively or negatively; we live our own lives. How can a science course contribute?

To develop social responsibility, or moral obligation, we must recognize a higher power than ourselves. In science, a child can get a personal contact with God, the highest power, the source of obligation, of responsibility. Again the activity program stands out as the most efficient way. Only through activity can the child discover for himself the *power* of the Creator. The child touches the things and learns of their mysterious magnificence. Our youth need a feeling of reverence and obligation for the things of earth. If they don't get this by self-discovery, no amount of preaching on property rights will be convincing, will lead to respect for property. On this issue of social responsibility we, as educators, have certainly failed. Most children do ***not*** respect property.

A child learns in science that each thing on this earth was created for a purpose. He examines that thing with his hands; he looks at the parts with a magnifying glass. Don't let him miss discovering those parts, finding out how each part helps the whole creature. Don't let him miss finding out the supreme qualities, the properties, the powers the thing has to accomplish its purpose through the operation of the parts. Let him talk about them. The plant and the animal must propagate. Study how this is accomplished, and within the social pattern of the family. There are many ways we can help children to be *convinced* of the veneration and integrity of the family through observation and discussion. A child can be led to see how the powers

of propagation of plants and animals and people on the three planes of living can give information that will help him solve many social problems for himself.

Passing into the field of non-living things gives the child a new area of thinking out life's problems. Forces of nature can help us do our work. The child studies these forces, investigates their source, determines their powers by experiment. He learns the laws under which they operate. He is not so blind he doesn't reason that there is a power behind laws that operate in such an important manner that they effect our ways of living. The child studies the materials that make the earth—our resources—minerals (chemicals), rocks (building materials), metals, water power (its sources), fuels, the soil. How did they get there? To whom do they belong? What can we do with them? Do we do it? If not, why not?

At this point correlations can be made with economic, social and political planning in the community, the state, the nation, the world. Does the use of things in science have anything to do with how we earn a living? With national prosperity? With international understandings? Can we increase business, spread jobs, by creating more abundance of the necessities of life rather than creating an artificial scarcity to keep prices high? Is nature stingy, or is man too slow, too dull, or too blind to see the work of providence? What about the plans of our politicians? Are they the better planners who created our present shortages of strategic materials, or did our politicians bungle? Are economics and sociology turning away from the principles of the Golden Rule when the only hope for fullness of life lies in following those laws? How does it happen that the more of science we have the less of peace we have, the less of brotherhood, the less of justice? Has man's interpretation of his stewardship of earth's goods fallen to a new "low"? Do the youth of America have opportunity of making a really better world?

In the course of these investigations the child meets with many surprises. He finds himself in the very center of a great many mystery stories. The mysteries of nature are sometimes called the magic of science. Why not capitalize on the child's living interest and curiosity about this world, and the problems we meet in using it? The mystery and magic of science excite the mind of the child. They are bound up in Nature's laws. He loves to see the laws work out—in the classroom, in his workshop, in nature itself. There is always a pattern. There is always one right way to put things together, and that right way makes things work. As I said before, children can reason for themselves. They can see that discovery of the laws of nature should make nature work for man's good, if he knows how to operate the controls, if he knows how to install the gadgets.

Through science a child can see for himself that man has free will, but plants, animals and non-living things do not have it. He observes that things in nature follow a definite pattern *always*. Man is the only creature that is free to do or not to do the things for which he was made. A child wondering thus within himself may become convinced that there is some reward in store for the one that always dares to do right, and some punishment for the one that always seems to "get by."

When it comes to practicing conservation the child with a scientific attitude sees the wisdom of avoiding waste. He sees that conservation is only living your own conclusions. Wildlife, the forest, the soil—they're all very important in the scheme for fulness of life. The reckless hunter, the careless camper, the improperly educated farmer just don't know what it's all about. One must be ignorant to think he can rule the world for his good by abusing it. Every state is spending tax money to the tune of millions annually to build up property that citizens tear down because, when they went to school, they did not develop social responsibility, nor reverence and a scientific attitude toward things of earth. Through science a youth can convince himself that "it's right" is a true standard, "get by" is a false one; that "what I want to do" may not be "what I ought to do" for my good and that of others; that consulting conscience is a better guide than watching the game warden.

Children are also impressed by the fact that the workings of many of nature's laws are incomprehensible to even the smartest of scientists. Who pushes the root bud, and the leaf bud from the seed? What makes light rays bend? How do trees know when to prepare for winter? How do birds know they are flying south? How does the squirrel know when to bury acorns? Does it ever bury wormy ones? How does a magnet get its force? Reaction can be judged, in general, by what one boy said, "You can't know God until you study the stuff He made." Robert Browning said it this way: "God made all creatures and gave them our love and our fear, to give sign we and they are His children, one family here."

You may explain to a child that magnetic force is due to the alignment of electrons within the molecules of the metal, but he may ask you: "How do you know they are lined up? How'd they get that way?" At the beginning of the unit on electricity you tell the children—we don't know what it is, but we know what it does. At the end of the unit you still say the same thing—we don't know what it is. How can we avoid the suggestion of an all powerful mysterious force? A child naturally calls for justice. If a Supreme Being made it all, and gave it laws to work for us, why don't we give Him the credit? A child finds it more reasonable to accept a Creator than the idea

that maybe the wind blew in some powerful cosmic dust that made a world. To that explanation the child might say: "Where did the dust come from? What started the wind blowing?"

If the child sees God as the Master Architect, the Master Mechanic, the Master Engineer, the One who really knows it all, the One you can't fool, the One that can do it easy—he doesn't need superman, or other questionable comics to excite him. I'll gamble on him to be a loyal citizen, and *not* a member of a subversive club. So much for developing social responsibility through realization of man's stewardship to a higher power!

Our third objective in science is to acquaint the child with science materials, to help him develop skills to use them, and to give him the opportunity to possess them so that he can carry science into his leisure hours—into his workshop at home. For our course up in the Valley we are developing kits of materials in each area of instruction. We have explored the hobby field and found kits in magnetism, electricity, motor and glider building, soil treatment, black light, along with splendid toys that educate scientifically. We have built units of study around kits we made ourselves. We have a mineral and rock kit, a fossil kit, a kit for making a miniature planetarium, a kit for making a razor blade radio set. I am collaborating with groups all over the country who are trying to get kits produced in quantity so that hobby shops in local communities can stock them for children to buy.

By use of kit materials we keep the course on an elementary level. When these children go to high school they will find a different presentation of science, different types of materials, a different administrative method. With the background we are giving children in grade school, high school teachers will have more time to administer the difficult parts of their science courses. They may be able to extend physics into fundamentals in radio and television, and biology into research on health and safety. We are not yet sure what effect an 8-year general science course in the grades will have on the high school program. It's too early to make statistical studies.

We have some knotty administrative problems in elementary science. The course must be designed for *every* child whether he is scientifically-minded or not, whether he has talent or not. All teachers must be able to teach the course, *all* children must be able to learn the course. In other words, elementary science must be easy, and yet challenging enough to develop leaders in the field. The course cannot be too lengthy for any one year, as many schools can give only 60 minutes per week to this subject. The health and safety program must get its proper time allotment. There are many demands on our

elementary schools. The science course should not be an unreasonable burden.

Let us summarize the requirements I have mentioned for an elementary science course. It must (1) build science vocabulary for enrichment through reading experience, (2) help the child to develop a social conscience through personal touch with creation, (3) acquaint the child with science materials and help him to develop skills to use them in a home workshop, (4) give the child a scientific attitude toward living in a scientific age, (5) be easy to teach, easy to learn, yet challenging to leadership in the field, (6) must not be too expensive to the school, nor to the child.

There are other objectives, but they are incidental, and will be realized along with the main objectives, for example, stimulating the child to habits of correct thinking; helping the child to follow directions; giving him a realization of the importance of order in one's own environment; stimulating him to habits of work which will really recreate.

Accomplishment of these objectives is a "large order" for a course that is conventionally considered to be the most difficult area of learning in the curriculum. But we think we have an answer. We have worked out what we call the work-text method of teaching and learning. We started with the science content in the curriculum, *Guiding Growth In Christian Social Living*,* and arranged it into a tentative course of study (cf. Tentative Science Course from Guiding Growth in Christian Social Living, Encyclopedia Britannica Films, Evanston, Ill., 50¢). The integrations are worked out in this course, and visual aids are suggested.

Working with a science committee in the Department of Education, Area of Green Bay, I am guiding workers setting up a series of units which we are piloting in some of the schools of the Valley. After the units for a certain grade are piloted and revised according to suggestions from participating schools, we collect these units into an envelope and offer them to schools to use. Within a year we will publish our worktexts for the first three grades. Those for other grades will follow. These basic worktexts are inexpensive, easy to teach, and easy to learn. Each will have materials which experience thus far has definitely proven will help teachers realize all the objectives, main and incidental, which I have outlined for you.

I am now showing you a sample unit and the manner in which it is taught. I have here a unit on Magnetism, second grade level. The teacher's manual shows the content as suggested in the curriculum,

* Joan, Sister M. and Nona, Sister M., Commission on American Citizenship, Catholic University of America, Washington, D. C.

Guiding Growth In Christian Social Living. The manual breaks the unit into lesson plans, lists words to be taught in each lesson, the materials to be gathered. The activity for teaching the concepts of each lesson is described, assimilation directed.

FIRST LESSON: Many magnets are made of steel. Magnets have different shapes. Magnets have a force. The force of magnets is a mysterious force that helps us do work.

Before the day the lesson begins, children are instructed to bring to class any magnets they may have at home. On the day of the activity the children show their magnets. (A children's collection exhibited.) They examine them. They see they are made of steel. The material is heavy. (Alnico magnets are not included in this unit, except that they come up for incidental discussion.) The words, magnet and steel, are written on the board.

Different shapes of magnets are discovered and discussed—horseshoe, bar, U, V, others. (These words are written on the blackboard.)

To show that magnets have a force, the teacher uses one very large magnet children have brought. It has a keeper on its poles. (Exhibited.) The teacher shows that the magnet can be lifted by taking hold of the keeper. The magnet pulls on the keeper. A pull (or push) is a force. Words—force, push, pull—are written on the board.

After some discussion the teacher works for integration by asking the question: "How do you think the magnets get their force?" Either the children will know the answer, or the teacher will tell them how magnets are activated. A current of electricity passed around the steel could make it a magnet. Children learn that the laws of science work to make steel a magnet when electricity flows around it. The children conclude that these laws work to cause magnets to get force. Other discussions may arise through children telling of experiences with magnets, even with electric magnets.

The teacher promises the children that they will have opportunities to study the force of magnets and learn how it helps us. (Pupil will probably volunteer information on these points, which can serve as a readiness program for what is to follow.)

Assimilation then takes place through the words on the board, on flash cards prepared by the teacher, and the exhibited magnets. Every teacher will know devices for having the children make up meaningful sentences from the words and materials on hand. This language correlation is very important to realize objectives of the science program. To strengthen understandings the worksheet is passed to each child. Drawings of the various shapes of magnets are on this sheet. Textual matter on the sheet is read and discussed, by the two-way method of reading, that is, teacher asks questions, chil-

dren answer after reading text silently. Children may draw pictures of their magnets.

Exercises on the worksheet can be done if there is time for enrichment. In the second lesson of this unit the children discover what things magnets pull; in the third lesson they discover what things magnets do *not* pull. There are ten lessons in the unit. After these lessons are completed (4-6 weeks) library periods follow. The teacher's manual suggests what books can be used for enlarging reading experiences in this area of instruction. (Unit, in both teacher and pupil form is available from Diocesan Department of Education, Box 186, Green Bay, Wisconsin, 15¢.)

We have prepared about 30 units in this fashion, on all grade levels. We are planning a total of 48 units, 6 per year, through 8 grades. We plan ultimately to teach laboratory biology in grade 9, thus releasing time to students for other courses in Senior High.

We are carefully evaluating results as we go along. We have written reports from pilot schools which give us a yard stick for measuring accomplishment of our various objectives. Time on this program does not permit further elaboration of our project, but we are *very much* encouraged by the results thus far obtained. We are pleased with the progress we have made in popularizing science teaching and science learning in the grade school—a course which we feel is doing much toward developing the children, because it is (1) enriching reading experience, (2) helping children to develop social responsibility through a personal touch with creation, learning at the same time how to use it, *not* abuse it, (3) helping children to develop skills to use available science materials in a home workshop, (4) helping children to develop a scientific attitude toward their world in a scientific age, (5) providing a course easy to teach, easy to learn, challenging science talent in youth, without being too expensive to the school, or to the child.

CULLODEN IMPROVES ITS CURRICULUM

By Effie G. Bathurst and Lucille McGraw Richmond. Office of Education Bulletin 1951, No. 2, 24 pages. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 15 cents.

In the elementary school at Culloden, West Virginia, a group of teachers, their principal, and their supervisor recently turned a formal and unsatisfactory school program into one that more adequately met the home and community needs of the boys and girls. The project was carried on under the leadership of the general supervisor, Lucille McGraw Richmond, who is responsible for the planning, research, and first report. Dr. Bathurst abridged the report and prepared the story for publication.

This bulletin reports the procedures used by the school staff in developing a better school program. It makes available to other teachers and supervisors the ideas found helpful by Culloden's staff and pupils.

THE PLACE OF THE LABORATORY IN THE TEACHING OF SCIENCE

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Among the many aims or purposes that have been listed for the teaching of science at the secondary school level I want to direct attention to only one: *The development of the scientific attitude, including a respect for truth and accuracy, an appreciation of the work of the scientist, and the spirit of investigation and research.*

John Dewey once said: "Since the mass of pupils are never going to become scientific specialists, it is much more important that they should get some insight into what scientific method means than that they should copy at long range and second hand the results which scientific men have reached. . . . Contact with things and laboratory exercises, while a great improvement upon textbooks arranged upon the deductive plan, do not of themselves suffice to meet the need. . . . There is sometimes a ritual of laboratory instruction as of heathen religion."[1]

What is uttered in that last sentence may be an explanation of what has been and still is wrong with the teaching of science. Surely, something is amiss somewhere if a philosophy of education assumes that real learning consists in the actual doing of what is to be learned, if there is experimental evidence which seems to indicate the contrary. Especially in the decade from 1920 to 1930 many experimental studies were made contrasting the results obtained between science classes taught by means of the laboratory and those taught only by demonstration. Too many of these studies were themselves open to challenge because of the unsatisfactory methods used, but, good or poor, the results seemed to present an indictment of the use of the laboratory as an adjunct to the teaching of science.

It is easy enough to see the reasons for the establishment of laboratories in connection with the work of science classes. During the period in our educational history when the study of science as nothing, more or less, than the acquisition of a body of factual information was the vogue, textbooks and lectures sufficed. Encyclopedic information marked the educated man. The more facts he had at his disposal, or, rather, the more facts he had thrown at him, the higher were the watermarks of his culture.

But there came a time when facts *per se* were vigorously challenged. Just as Dewey said, education had been entirely too much a deductive process, in which everything was poured into the individual

[1] Dewey, John, *Democracy and Education.* The Macmillan Company, New York, 1916, pp. 258–259.

without his being required to furnish any evidence that he could in any way, shape, or form apply his highly intellectualized knowledge to the affairs of his everyday life. The old theory of formal or mental discipline was in entire accord with this procedure. Then, when this theory was attacked by Thorndike, James, and Judd, and when the Herbartians emphasized the inductive method of learning, the teaching of science fell into line by introducing personal and individual experimentation in a laboratory provided for that purpose, the assumption being that the five-fold step process would turn an erstwhile layman into a full-fledged scientist. The substitution of the laboratory method for the teacher lecture-demonstration was made in the hope that the actual conduct of the experiment kinesthetically would produce a deeper and fuller understanding of the inner workings of the scientific mind.

I use the term "substitution" advisedly, because that is about all it was. If the experiment had been demonstrated to the group, which is still the stereotyped procedure, the pupils were expected to go into the laboratory, set up apparatus of a nature somewhat similar and often inferior to that employed by the teacher, and produce the same results. The pupils blindly tried to remember what steps the teacher had followed, or else they consulted a specially prepared manual which told them what to do and then asked them what they got. Of course, there were teachers who saw more into laboratory work than the procedure just described, but they were decidedly in the minority. Although the faith of the majority may have been based on a so-called scientific method, they endeavored to get it across to their pupils either through dependence upon the doctrine of formal discipline or through mental telepathy.

Achievement in the laboratory was measured by means of the notebook, which was supposed to furnish tangible evidence of the scientific accomplishments of the experimenter. Consequently, the notebook became the ***summum bonum*** in the contest between teacher and pupil to get the latter to imitate the former in the performance of any given experiment. What more natural, then, than that emphasis should be placed upon the externals—the way in which the experiment was written up, the cleverness with which the necessary drawings were executed, the mathematical accuracy of the computations, and the neatness of the whole thing? So there was a shift from the immediate or ultimate significance of the experiment in the lives of the pupils to the importance of the outward form in which it was written up. But, through the minds of the pupils would run such questions as these: Is this what the teacher wants? Am I following the directions in my manual as I should? What is it that the manual says for me to do next? Am I going to get the right answer? What is

the fellow next to me getting? and so on. To make matters worse, there are now certain manuals which go to the extreme of providing special spaces or blanks for recording every single step to the separate parts of the experiment. They seem to be contrived so as to permit the pupil to do a minimum of his own thinking. They further lead him to the belief that a blind following of the printed directions will lead to a blind acceptance of the true place of the experiment, not in its scientific applications, but in the grade which he will receive from the teacher.

Is there any wonder, then, that educators began to question a type of procedure from which pupils seemed to gain so little? The attack took the form of advocating the use of the demonstration in the place of laboratory experimentation. Reference has already been made to studies based on comparisons of test results between groups taught by the two different methods. In general, the results tended to favor the demonstration method, whether on immediate or delayed recall. The inference adopted by many school people was that more good would be accomplished on behalf of the ordinary pupil if the teacher were to use the lecture-demonstration in place of the laboratory. And all this, in spite of the fact that the tests measured only factual data. In fact, such a furor was created that many schools cut down on any lengthened or double period for the laboratory and allotted the science class the same short period enjoyed by other classes. The economy argument was a potent one—we can economize on space, since the laboratory can now be put to other uses; time will be saved, since double periods will not be necessary; and the budget will be reduced through the elimination of the purchase of individual laboratory equipment and supplies.

But the last stanza of the song has yet to be sung. In addition to the interpretations that have been accorded the results of the tests given to control and experimental groups, there may be another side to the whole question. There are two ways in which we may regard the outcome of an action: the first is to declare that the outcome proves unquestionably the worth or worthlessness of the action; the second is to challenge the *character* of the action that is seemingly responsible for the outcome. In other words, if fault there be, it might presumably lie in the conduct of the action rather than in the action itself.

And so with the case of the laboratory. As the reference from Dewey stated, "Contact with things and laboratory exercises, while a great improvement upon textbooks arranged upon the deductive plan, do not of themselves suffice to meet the need." My claim is that teachers have assumed so much of automatic transfer from the performance of laboratory exercises of the repetitive and manual type to the development of a scientific attitude of mind that *they have*

neglected to analyze the steps necessary to make a reality of this transfer. "Why, of course," they say, "you must have this most desirable quality (scientific attitude), since you turned in such a beautiful notebook." On the same analogy, one might be safe in saying that a person who wears a new suit of clothes is also wearing clean underwear.

Well, shall we throw overboard our laboratory technique? The substance of it, No! But the major part of it, Yes! The stereotyped sort of material that clutters up our laboratory work tables needs to be swept off into the rubbish heap. We need to reformulate our methods so as to make them more nearly conform to our aims. Dewey's blast was directed against the kind of science teaching based entirely upon the deductive method, whereby pupils are told what's what and what to do. His zeal, however, carried him too far, when he stated that the deductive method is not a part of the scientific method. It most certainly is. It would be utterly impossible for any progress to be made in the world of science if each individual had to begin at the beginning and bring his own knowledge and practice up to date. He simply has to take what others have already discovered and proceed to build upon it. Nevertheless, in the process of learning, he must also find out how to discover things for himself. This is the inductive method, the one advocated by Dewey. What we need is both methods, not just one to the exclusion of the other.

That pupils learn via the deductive method receives ample testimony from the studies which indicate a superiority of the lecture-demonstration method over the use of the laboratory. My claim, substantiated by Dewey, is that this is not enough. Why? Because the laboratory itself has been conducted along the lines of the deductive method. In carrying on an experiment, pupils have been given explicit directions on *what* to do and *how* to do it. There has been no opportunity for them to go through the various experiences of being faced with a problem for whose solution there are no prepared directions and no predetermined answer. This is the probable explanation for the superiority of the lecture-demonstration method, as claimed by many educators, over the laboratory method. If all that we are supposed to gain from our study of science is the possession of an assemblage of factual information, why shouldn't the lecture-demonstration method be satisfactory for this purpose? But, if we are supposed to achieve wholly or even partially our objectives, then I doubt if the lecture-demonstration method will suffice. "Learning by doing" certainly cannot become a meaningless phrase in the teaching of science. If it is to find no place here, then it should be discarded as an outworn slogan.

If, then, there is any worth in the inductive method, we must

reorganize the way the laboratory is conducted, because it must be the way the laboratory work has been carried on that is at fault. How can this be done? My first suggestion is that the science course be organized on a problem basis. If there is one major emphasis among all the aims for teaching science that have been listed by others, it is that of the contributions which the course should make to the pupil in his better understanding of the world of science in which he lives, in his ability to use this science for his own purpose, and in the way that science affects him personally. The corollary is that the content of the course should bear upon his necessities and his experiences in daily life. The ideal method to achieve this end is to have the course develop out of the problems raised by the members of the class. The first two or three weeks may well be spent in assembling all the what and why questions which the pupils are sure to raise: "What happens when you do this?" "Why does this happen?" etc. These questions will be turned into problems, and the problems will lend themselves to some sort of classification, such as sound in physics, respiration in biology, oxidation in chemistry, etc.

The next step is to analyze those factors that need study and experimentation. For some of them we shall find that reading will give us all the information that we need. For others, the lecture-demonstration method, whether by teacher, pupil, or projector, will suffice. But, for certain others, it will be necessary to have recourse to the laboratory. This is when we are faced with a problem to which we do *not* have a ready-made answer. Of two similar electric light bulbs, one of which costs fifteen cents and the other twenty cents, which is really the cheaper? Does cane sugar make better jelly than beet sugar? What effect will the addition of certain minerals to the soil have upon the nutritive value for a certain plant? What effect will the presence or absence of sunshine have upon growing things? What do you have to do to get grass to grow on the school lawn? What's the best kind of dog food for my dog? Why does a fuse blow out?

Topics like these are the ones that may arise in what I prefer to call the class conference. This is the place where all the discussion, planning, and demonstration are carried on. Many of the problems will be settled right there. The answers to others must be obtained from experimental work that can be carried on only in the laboratory. The laboratory, then, becomes an ever present help in time of trouble. There is never any set day for it. It is used only when needed. It becomes the servant, not the master, of the inductive method of teaching. That is why the lengthened period is so advantageous for the teaching of science. The class does not have to have laboratory work on certain days, as is always the case with the double period. Since the double period schedule restricts laboratory work to certain defi-

nite days, what often happens is that there is little or no connection with what is done in the class conference (recitation period) and the experiments performed in the laboratory. Especially is this true where a manual is slavishly followed. A combination of these three factors, a set day for laboratory work, a divorce between "recitation" and laboratory work, and a deductive type of manual are, to my way of thinking, responsible for the seemingly poor results that hinge upon the stereotyped laboratory method of teaching science.

And so, in the class conference, the decision is reached as to which problems need to be solved in the laboratory. Plans are made as to whether the work is to be assigned to individuals or to groups, as to the necessary apparatus to be used, and as to the length of time, in number of laboratory periods, to be spent on the experiment. When the work has been done, the whole group reassembles in the class conference and presents the results of its findings.

Then comes the most important phase of all, that of analyzing and discussing the various steps that attend the inductive approach—the statement of the problem and the reasons why it is a problem, the techniques used in solving the problem, the discovery of the solution, the sources of "probable error,"[2] the applications, and the effect which the whole performance of the experiment makes upon the thinking of the group.

It is rash for anyone to express too much confidence in a particular procedure, but I do feel quite sure that Dewey's concept of scientific method and attitude will be approximately realized through the approach that has been recommended in this paper. At least, an attempt has been made to apply "Learning by doing" to that area to which it seems to be most naturally and closely related. Pupils will have come nearer to realizing the aims that have been set forth. Who knows but that they may become even more intelligent American citizens?

[2] "A value that any given error will as likely fall under as exceed." Webster's New International Dictionary.

HOTTEST FLAME

The hottest flame that man has ever created, fluorine burning in hydrogen, at 8,000 degrees Fahrenheit was described by Dr. A. V. Grosse of Temple University's Research Institute at a meeting celebrating the National Bureau of Standards 50th Anniversary.

Comparing the flame directly with the sun, Dr. Grosse and his team found that at ordinary atmospheric pressure the temperature was 7,000 degrees Fahrenheit (4,300 K.) which increased to 8,000 degrees Fahrenheit (4,750 K.) when under five atmospheres pressure. The sun temperature is 9,000 degrees Fahrenheit and with higher pressures the Temple University scientists expect to reach sun temperature on earth.

The oxy-aluminum torch in previous Temple experiments had been able to melt anything against which it was directed, but the even higher temperature of the hydrogen-fluorine torch will likewise melt everything so far known on earth.

TEACH THEM SLIDE RULE

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It is an age of gadgets and "gimmicks." Salesmanship and advertising use such devices more and more, daily. The more of them we have and play with or use, the more clever we rate ourselves, as a nation. Our employment of them has become a sort of index of intelligence exercised subconsciously, it would seem. Why not use the slide rule as an instrument of motivation in the study of arithmetic and higher mathematics? In truth, it is much more. It is a valuable tool. It has come into more and more universal use during and since the Second World War, whereas, at the time of the First World War, only engineers understood its mysteries, it seemed.

Who should learn to use the slide rule? Once interest is aroused, anyone who can perform the four fundamental operations with integers can be taught to use the slide rule, with conviction of its accuracy. It is not necessary to understand the basic principles back of it and its construction. However, it is highly desirable to understand them. When the learner has progressed far enough in mathematics to understand, he should be guided to know just why the slide rule "works," as he says. Until then, the verification of the answer by basic arithmetic should bring conviction of the slide rule's accuracy—a practice frequently used in education. The proof of the pudding is in the eating. If by use of the slide rule, 2 times 3 equals 6 and 4 times 9 equals 36 and 72 divided by 8 equals 9 and 288 divided by 12 equals 24—any such operation of multiplication or division checks against the simple arithmetic employed to arrive at the result, then the slide rule if carefully used according to directions, will produce correct answers. A seventh or eighth grade pupil or one even younger will agree with this conclusion.

The next thought of such a pupil is "Why bother?" Basic arithmetic is as quick and perhaps accurate to more significant figures. Truly, he must learn by further experience, that we can multiply a number of three figures by another, of three, much more quickly with the slide rule than with the use of paper and pencil. Moreover, with practice, one can perform the multiplication by slide rule almost automatically or mechanically, to an accuracy justified by the basic data of multiplicand and multiplier, particularly if these latter represent observed measurements. Adolescents realize that routine frees us for further thinking, planning, reasoning of a higher type.

During the last war, a young married woman who was a university graduate, wishing to contribute toward winning the war, applied for

a certain position. She was asked if she could use a slide rule. Immediately she replied that she had never touched one; that she "never could do any simple arithmetic correctly." She was then told that the operations she would need to make, in the position under consideration, were purely mechanical, required good vision and accurate reading of figures, only. She admitted that she could read accurately. She was tried in the work. Her employers found that she could perform quite well the needed operations on the slide rule and procure the results desired with no knowledge of the instrument excepting mere rule of thumb use. She was much amused, then, at her own earlier anxiety as to her believed inability. She held the position, in a most satisfactory office environment, receiving good remuneration until the end of the war.

How expensive is a slide rule for a seventh grade pupil? Well, slide rules of sorts can be purchased for twenty-five cents. Or possibly the instructor can procure some logarithmic paper, cut strips, teach children how these strips should be scaled with numbers, then slide one strip along the other, even to make a transparent indicator to slip over the two strips of paper scaled when purchased according to the logarithms of the successive integers. Such a slide rule costs almost nothing at all. It will stimulate interest in the subject of arithmetic. It tends to rouse the feeling of achievement and possibly of curiosity to learn the why and wherefore of the instrument. The tool may be picked up and used at intervals through the study of fractions, common and decimal, and proportions in the later years of the youngster's study.

He finally may come to take a course in intermediate algebra in secondary school. Then he should receive a thorough understanding of the theory of exponents and subsequently of logarithms, particularly with emphasis on powers of 10, and base 10. Now he is ready for a thorough understanding of slide rule, so much so that he could eventually construct one with mere straight edges and a table of two-place logarithms. He should realize that basically the integer-labeling on the rule is the antilogarithm or number of which the portion of the rule scaled to the integer is the logarithm. He should realize that the scale is begun with the digit "1" in that the logarithm of 1 to the base 10 is zero or putting it exponentially 10 to the zero power equals 1. An exponent 0 produces an antilogarithm or number 1.

Set the C-index of the slide just above 2 of the stock. Then read just below 3 of the slide. One finds 6 on the stock. Actually one has added mechanically that portion of the rule scaled to the logarithm of 2, on the stock, to the scaled portion of the slide representing the logarithm of 3, by combining by extension two segments of wood or plastic to produce the sum on the stock, marked "6," which is actu-

ally only the label for the scaled logarithm of 6. We have multiplied two numbers to the same base by adding their logarithms by the simple device of extension of a portion of the stock by means of a portion of the slide. Understanding the theory of exponents and therefore of logarithms there is nothing mysterious about a slide rule. It is so simple and obvious. Using exponents, we multiply by addition, divide by subtraction, square by doubling. Our object here is understanding of the principle upon which the instrument is constructed.

Testing the use of the slide rule, at this stage, should be for understanding. A brief sentence, oral or written, explaining the setting and reading for each operation should be required. Speed at arriving at results should come later. One could spend a semester on study with the slide rule. It is done. Or one can teach its understanding in a week or so. Men training in electronics in the navy must acquire speed so that they maintain facetiously that in their tests, their slide rules smoke. This sort of experience is university level requirement, not expected in secondary schools. However, some pupils find the slide rule intriguing. It becomes pocket equipment with pen and mechanical pencil. Its use is carried over to physics and chemistry—almost automatically used for computation or for checking.

Frequently we are asked about the circular slide rule, one disc concentric with a larger one fastened with a grommet, rules such as are used in aeronautical navigation. Again there is no mystery. Imagine an ordinary slide rule made of heavy sheet rubber scaled and numbered as usual. Now, if the elastic would permit, bring one end around to fit perfectly to the other, meanwhile keeping the instrument flat, a plane, in other words, the outer edge stretching uniformly to a circle while the inner contracts uniformly to a mere point at the grommet. There you have a circular slide rule to be used exactly as the straight one, yet capable of carrying 360° about its periphery, an attribute impossible with the ordinary slide rule, but so essential to all navigation.

There are fine large demonstrators of the ordinary slide rule such as can be read from any position in a class room. The faculty of a large school, owning one may move it from room to room, suspending it when needed from the top edge of a black board or picture mold. Pupils in courses other than mathematics eagerly request information concerning its use, as they enter or leave the room in which it hangs. Adjustments of its slide and indicator are almost as frequent before and after school and between classes as during classes.

Who can predict that a youth will or will not, later in life, need the use of a slide rule? We have in it an instrument to motivate interest in mathematics. Who will say that the youth will not need accurate arithmetic?

THE LAUE X-RAY DIFFRACTION EXPERIMENT

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Apparatus commonly used in the taking of Laue photographs is so expensive that it is beyond the reach of the average laboratory; however obsolete medical x-ray equipment may often be obtained free or at a fraction of the cost of new equipment. This type of equipment may be used for this purpose, together with a camera assembly and a lead-lined box that may be constructed at small cost. A description of this may be of interest to those experiencing a similar lack of equipment.

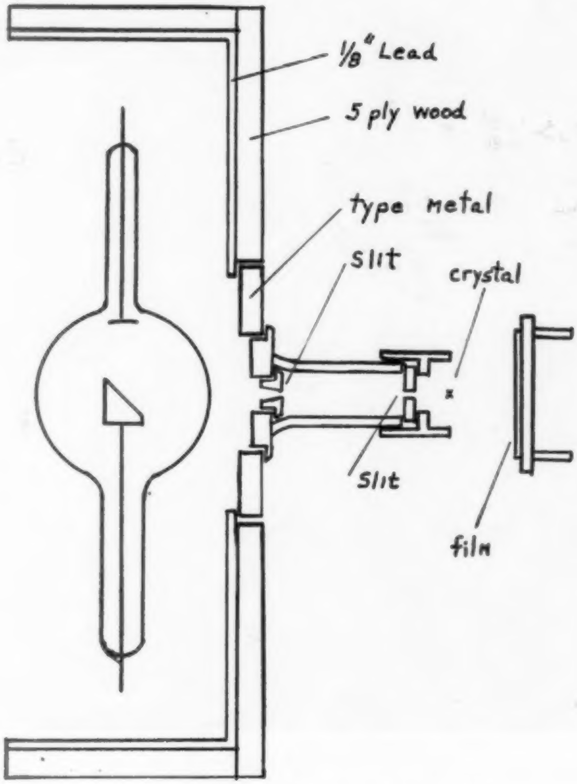

FIG. 1. Arrangement of camera assembly.

The arrangement of the equipment is shown in Fig. 1. The tube is housed in a wooden box, $10\times10\times26$ inches outside dimensions. The box was lined with lead $\frac{1}{8}$ inch thick. The collimating tube is attached to a piece of type metal, 7×10 inches in area and $\frac{7}{8}$ inch thick, which forms part of the front of the box. The collimating slits are circular holes, made with a No. 57 drill and placed in the center of circular

pieces of lead, one inch in diameter and about $\frac{1}{4}$ inch thick. These slits are about 10 cm. apart in the collimating tube. The one nearer the film is adjustable so as to facilitate alinement with the target of the tube.

FIG. 2. Laue photograph of calcite.

An old commerical Coolidge fine focus x-ray tube was used. It was operated off a Standard X-Ray Company, 100 KV mechanical rectifier outfit. By using electric fans to cool the tube and transformer, it was possible to operate the tube continuously at about 60 KV and 3 milliamperes.

Alinement was checked by placing a fluoroscope in front of the

collimating slits, but with the eye always at an angle to the x-ray beam. A final check was made using a two minute exposure on photographic film.

The crystal is placed on Scotch tape and placed about 1 cm. in front of the second slit. The film is placed from 5 to 10 cms. in front of the crystal. Satisfactory results were obtained with exposures from 4 to 6 hours at 60 KV and 3 ma. Figure 2 shows a photograph of calcite. The exposure time was 4 hours and 40 minutes at about 60 KV and 3 ma. The distance from the crystal to the film was 5 cms. Kodak no-screen medical x-ray film was used, and contact prints were made on Ansco No. 4 glossy paper with D-11 developer. A photograph of the equipment is shown in Fig. 3.

FIG. 3. Apparatus for Laue photography.

Several methods have been suggested for performing this type experiment. Hoag and Korff[1] give definite laboratory procedure. Weber, McGee, and Gerhard[2] have obtained results with obsolete medical equipment, while Miller[3] and Radisch have reported excellent results with dental equipment. No doubt others have successfully adapted obsolete x-ray equipment for this use.

Several of our students have constructed gnomonic projections

[1] Hoag and Korff, *Electron and Nuclear Physics*, D. Van Nostrand, 1948, pp. 224–25.
[2] A. H. Weber, J. F. McGee, and K. F. Gerhard, *Am. Phys. Teacher*, vol. 5, pp. 279–80, 1937.
[3] R. F. Miller and William Radisch, Paper given at Kansas Academy of Science, May 4, 1951.

from our photographs of rock salt and calcite, using the procedure outlined by Sproull.[4]

Appreciation is expressed to Professor P. C. Sharrah, University of Arkansas, who first suggested the possibility of our doing the experiment in this manner; to Mr. L. P. Clayton and Dr. M. B. Casebolt who gave the equipment; and to Robert Barto, James Haslett, Robert Fitzwater, and John Casebolt who helped assemble the equipment and take the photographs.

[4] W. T. Sproull, *X-Rays in Practice*, McGraw-Hill, 1946, pp. 371–78.

BIRTHPLACE OF ARCTIC ICE ISLANDS NORTHERN CANADA

The probable birthplace of the three large islands of ice floating in the Arctic Ocean has been sighted on the north coast of Ellesmere Island in far northern Canada. The islands have an area of up to 300 square miles.

Capt Lawrence S. Koenig of Eilson Air Force Base, reported to the Second Alaskan Science Conference here that he had seen there a landlocked ice sheet or shore glacier with the same characteristic markings as the floating islands. From an altitude of a few hundred feet it was impossible to tell whether the markings were water or clear ice. They gave the appearance of rivers and brooks draining the ice just like on land.

Scientists and military officials believe these islands—and others which may be discovered—might be useful as mid-ocean landing strips. They could hold camps, either military of scientific, without the danger of camping on much more fragile ice floes.

The drifting course of the third island was revealed for the first time by Capt. Koenig. First sighted in 1946 north of Point Barrow, the northernmost tip of Alaska, the island drifted in the Beaufort Current near to and beyond the North Pole. It was lost for almost two years north of Greenland, but was sighted again in August of this year 50 miles off the coast of Ellesmere Island. In five years the island has drifted some 3,000 miles. In all these years the shape of the island and its markings, which are its "fingerprints," changed so little that identification was easy. Two other ice islands are being consistently followed by the Tarmagan polar weather flights. The islands are obviously different from the pack ice which fills the Arctic Ocean. While the pack ice drifts with the wind, the ice islands seem to follow the circulatory Beaufort Current, a gigantic eddy covering half the Arctic Ocean.

ROSE CLOVER FROM TURKEY FOUND SUPERIOR FORAGE CROP

After seven years of trial, one of the most outstanding introductions of forage plants in recent years has proved to be rose clover.

Imported from Turkey in 1944, this winter annual legume is now being planted by farmers and ranchers in many California winter pastures.

As a forage plant rose clover ranked higher than bur or sub-clover in 14 of 25 plots in various parts of the state, in tests reported by R. Merton Love, professor of agronomy, University of California College of Agriculture.

Rose clover grows well on poor soils which would otherwise be unsatisfactory as pasture. After a few years' growth this plant crowds out most of the undesirable summer weeds. Like all legumes, this plant adds nitrogen to the soil. Many desirable grasses can then enter rose clover seeded areas voluntarily.

This legume shows great promise as a pasture plant in burned off areas. In many places it has done better than bur clover during severe winters. Ample seed is available commercially.

THE SCIENCE LECTURE IN THE HIGH SCHOOL ASSEMBLY

V. THE HYDROGEN BOMB

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In these days of uneasy peace, and even of large-scale, although unofficial, war, we see frequent reference in the public prints to a new and more devastating weapon than any yet devised by man. I speak not of the improved uranium bomb, but of the far more destructive hydrogen bomb.

It is no secret that American military authorities are at work on the hydrogen bomb, for President Truman announced on January 31, 1950 that he had ordered the Atomic Energy Commission to proceed with the construction of this weapon. Please note that I say weapon, because it is believed that no other use will be found for such a contrivance. By this I mean that the following distinction exists between the possibilities of the indirect benefits of the uranium and the hydrogen bombs to mankind, namely, the development of the uranium bomb resulted in peace-time blessings which will continue to stagger the imagination and to challenge man's ingenuity in medical, biological and industrial advance, but the hydrogen bomb, let us be clear, will be a weapon, and never anything else. No peace-time progress will result from it, for although the reaction of hydrogen fusion appears to be under control on the stars, this is probably true because of their immense size, the outer regions preventing the interior from cooling off—on the Earth we will not be able to control the reaction, because it is not possible on a "small" scale to prevent the necessary heat from escaping. The result is that we have the choice only between making an explosion or having no action at all. There is no "in between" possibility.

It might be helpful to bear in mind another contrast, only for understanding the workings of the two kinds of bombs. You will remember that the uranium bomb contains a charge of uranium or of plutonium, either of which, when made to exceed "critical mass" size, by bringing several pieces together, undergoes a splitting of atoms, with the final result of a frightful explosion, a release of radiations of several kinds, and a tremendous blast of heat. This splitting of atoms is known as "fission." The hydrogen bomb, on the other hand, causes atoms not to split apart into something smaller as in a "fission" bomb, but to go together into something larger, (see Slide I) and is called, therefore, a "fusion" bomb. In this "fusion" bomb, a certain kind of hydrogen atoms is driven together (fused), and converted

SLIDE I. A few examples of the energies released when light nuclei are fused. Note that the release of the greatest amount of energy (highest Mev.) in this table results from the fusion of tritium and deuterium. This forms helium and free neutrons, and is probably the same process which produces the heat of the sun.

Nuclear Particle	*1. Symbol of Particle* *2. "Equation" for Preparation of Particle by Fusion*	*Mass*	*Mass-deficit* (loss when fusion of nuclei takes place). Obtained by subtracting mass of new particle from sum of masses of particles present.	*Binding energies* (same as mass-deficit changed into Mev., i.e., million-electron volts). Since one unit of mass is the same as 931 Mev of energy, if we multiply mass deficit by 931, the answer is the energy released when the lighter particles fuse into heavier ones
Proton	1) ● or $_1H^1$	1.0076	—	—
Neutron	1) ○ or *n*	1.0089	—	—
Deuteron (deuterium nucleus)	1) ●○ or $_1H^2$ 2) ●+○→●○+2.18 Mev (see column 5)	2.0142	*Theoretical mass* ● 1.0076 ○ 1.0089 2.0165 *Actual M.* 2.0142 *Deficit* 0.0023	0.0023×931 Mev = *2.18 Mev*
Triton (tritium nucleus)	1) ○●○ or $_1H^3$ 2) ○+●+○→○●○+8.29 Mev (see column 5)	3.0165	*Theoretical mass* ● 1.0076 ○ 1.0089 ○ 1.0089 3.0254 *Actual M.* 3.0165 *Deficit* 0.0089	0.0089×931 Mev = *8.29 Mev*
Alpha Particle (helium nucleus)	●○ 1) ○●○● or ○● 2) ○●○+●○→●○●○+○+17.7 Mev (see column 5)	4.0028	*Theoretical mass* ○●○ 3.0165 ●○ 2.0142 5.0307→5.0307 *Actual M.* resulting from fusion ●○●○ 4.0028 ○ 1.0089 *Actual M.* 5.0117→5.0117 *Deficit*→0.0190	0.0190×931 Mev = *17.7 Mev*

into helium atoms, this change also resulting in the release of tremendous amounts of heat. So we see that heat is released, in gigantic amounts, in both fission (uranium) and fusion (hydrogen) bombs.

I pause for a moment to remind you of a few things which may have slipped our memories since the lecture on the uranium bomb. One of these things is that when we speak of splitting or fission of atoms, we

really mean fission of the nuclei of the atoms, and the same is true of fusion, i.e., a fusion bomb is so called because in it light nuclei fuse into heavier ones. Another thing which we should recall, before going further, is the meaning of the term "isotope." This term is applied to the several forms of the same atom, in which the only difference is in the number of neutrons in the nucleus. Since neutrons lend nothing to the *chemical* properties of an element, the isotopes of the same element will all have identical chemical properties. The only differences between isotopes of the same element will be in atomic weight, radioactivity, and other *physical* properties. When I used the expression "certain kinds of hydrogen atoms" a moment ago, I meant certain isotopes.

You will probably be struck by the fact that the two kinds of bombs seem to be opposites in another sense—that one employs the heaviest atom and the other the lightest. There is a good reason for this—much energy is released when the heaviest atoms are *split*. As we go down in the list of elements from uranium (atomic weight 238), to silver (atomic weight 108), we note that less and less energy results on fission of the atom, so that any element below silver in atomic weight would absorb heat, instead of giving it off! These elements would therefore not be useful for making a fission bomb. On the other hand, light elements release energy when their atoms are *fused*, and the lighter the atom the less energy is required to fuse them and make them able subsequently to give off energy.

There is still a third way in which these two weapons differ, namely, in size. You will recall that there is a certain size called "critical mass," which, when exceeded, results in an explosion. To quote Louis N. Ridenour (*Scientific American*, March 1950), one of the great scientists in this field: "The greatest ingenuity is needed to achieve an instantaneous condition exceeding the critical by as much as a few per cent; no amount of ingenuity has yet allowed the design of an efficient fission bomb so much as two or three times critical size. Thus there are inherently narrow limits to the size of a fission bomb: as it begins to exceed the critical, it explodes at once; if it is smaller, it cannot be exploded at all." A hydrogen bomb, on the other hand, can be made any size desired, in other words, there is no "critical mass" in a hydrogen bomb, and the larger, of course, the more destructive it will be. Upon this fact is based the statement that the hydrogen bomb may be several thousand times as powerful as the uranium bomb, merely because it can be made larger in *size*.

Having noted that a fusion bomb has no limit placed upon its size, and can therefore be made so much more powerful than the older bomb, let us see why hydrogen is selected as the active ingredient. As has been said, fusion of nuclei releases enormous amounts of heat,

but the energy needed to cause fusion is so great that only for the lighter elements is the energy later given off greater than that invested in bringing about the fusion. Indeed, fusion of atomic nuclei is a difficult process to bring about, because, you recall, the nucleus is charged positively, and nuclei will therefore repel each other violently since they all bear "like charges." It is clear that because this tremendous repulsion of nuclei for each other must be overcome before the nuclei can come together and fuse, enormous energies are needed to bring about fusion of nuclei. At first glance it would seem impossible for man to attain such energies. That they are attained in Nature's laboratory at every instant, is shown by the fact that it is precisely this fusion of hydrogen nuclei taking place upon our star, (the sun), that results in the release of the energy constantly coming to our planet, flooding us with the benign goodness upon which all earthly energy and life are based.

Having, for the reason given above, selected hydrogen for the fusion bomb, we may next note that it will pay us to be particular concerning which isotope of hydrogen to select. From the table, (Slide II), it will at once be clear that if we choose the easy way out and select ordinary hydrogen we shall have to wait around in the hereafter a little while for the bomb to go off, since it takes one hundred billion years for such hydrogen nuclei to fuse! The table also shows which of the isotopes of hydrogen is the best choice—namely, a mixture of hydrogen of atomic weight two ("deuterium") and of atomic weight three ("tritium"). Our first table, (Slide I), shows us that a deuterium nucleus, called a "deuteron," contains one proton and one neutron, while a tritium nucleus, called a "triton," contains one proton and two neutrons. Note the enormous energy release—17.7 million electron volts—an amount far in excess of that given off by any other combination of isotopes of hydrogen. This reaction is, as I have already said, the very one constantly proceeding on our sun—deuterium plus tritium fusing to produce helium, (so named from the Greek word for sun because it was discovered to exist on the sun), plus neutrons. I trust that none of you will start fretting about the likelihood that if this process goes on much longer it will result in the sun's finally "burning out" to helium. One reason that you need not worry about this probability is that only 1% of the sun's hydrogen is fused into helium in one billion years. So let us stop worrying about this sad thought right now!

As to how to get our mixture of deuterium and tritium to fuse, let us note that this can be done by exposing it to outlandishly high temperatures. This is called a "thermonuclear reaction"—a reaction in which high temperatures act upon atomic nuclei, causing them to undergo a change. On the sun, the heat necessary to bring this reac-

SLIDE II. Energies released by, and time required for, fusion of nuclei of the isotopes of hydrogen. Note the tremendous speed and high amount of energy involved in fusion of tritium and deuterium nuclei.

Isotope nuclei fused	*Energy released*	*Time required*
${}_1H^1 + {}_1H^1$ (light hydrogen i.e. proton)	1.4 Mev	100,000,000,000 years
${}_1H^2 + {}_1H^1$ (deuteron plus light hydrogen, i.e. proton)	5 Mev	0.5 second
${}_1H^3 + {}_1H^1$ (triton plus light hydrogen, i.e. proton)	20 Mev	0.05 second
${}_1H^2 + {}_1H^2$ (deuteron plus deuteron)	3.2 Mev	0.00003 second
${}_1H^3 + {}_1H^2$ (triton plus deuteron)	17.7 Mev	0.0000012 second

tion about is constantly present at its center, where the temperature is about twenty million degrees. The problem of attaining this temperature on Earth, so as to make the hydrogen bomb possible, is solvable when we recall that we can use the uranium bomb to release tremendous temperatures. The design of the hydrogen bomb will therefore call for:

(a)—a mixture of deuterium and tritium as the active ingredients
(b)—the uranium bomb, attached to this mixture, so that when the uranium bomb is exploded it will generate so much heat as to make the two isotopes first to fuse, then to release tremendous energies in the form of blast and fire.

The uranium bomb, it will be recalled, permitted only 0.1% of its charge to undergo fission. The fusion of hydrogen nuclei, to form helium, permits 0.7% of its matter to undergo change, but we must guard against assuming that because we thus have an increased use of raw material we can plan more powerful bombs by changing the design so as to make a higher percentage of material undergo fusion. This is not so, because all that we have done is to release the "binding" energies which hold the protons and neutrons together. To further increase the output of energy we would have to convert the entire proton or the neutron into energy, a process which physicists believe will never be possible (although smaller particles, such as electrons and mesons can be annihilated).

While we are on the subject of the energy associated with the nucleus, permit me to try to clarify a few important points: However strange it may seem to you, it is nevertheless true that when a proton and a neutron approach each other they attract one another, unite and cohere, produce the nucleus of deuterium (called a deutron), and give off energy. Because the two particles have been bound together this energy is called "binding energy." Now energy is a form of mass,

and, since energy has been given off, the end product, deuterium nucleus (or deuteron), should have a smaller mass than the sum of the masses of proton plus neutron. This, in fact, is the case—(see Slide I). The deficit thus produced in the mass is the mass of the binding energy which has been given off. I think that it is a remarkable thing indeed, that Albert Einstein announced this principle as early as 1905 in connection with his relativity studies, at a time when no such thing as either a nucleus or nuclear physics was known. The next time you hear someone laugh at "ivory-tower" scientists and mathematicians, remind him of this, one of the great feats of all time.

Perhaps you will remember that in the lecture on the uranium bomb, it was pointed out that before we knew how to obtain energy from the nucleus, all chemically-made energy was obtained from the outer or planetary portion of the atom, and by comparison with atomic energies, was small. When you recall Einstein's equation, $E=mc^2$, and apply it to compute the energy equivalent to mass, you find that one mass unit equals 931 Mev. (million electron volts). The loss in mass sustained when one proton and one neutron fuse is 0.0023 unit (see Slide I). If we multiply 0.0023 units of mass by 931 Mev., we change the mass units into energy units—in other words 0.0023 unit of mass is the same as over two million electron volts of energy. Likewise, the loss in mass sustained when one nucleus of deuterium and one of tritium fuse to helium is 0.019 unit of mass, which when changed into energy units by multiplying by 931, equals over seventeen million electron volts. You therefore see that release of energy by mass can become tremendous, and does so in the hydrogen bomb, in the form of blast and heat.

Column five of our table (Slide I) shows that as the number of particles in the nucleus increases, the binding energies increase and that therefore the energy which can be released by making the larger nucleus increases. The more numerous the particles, the greater the attraction between them, hence the greater the loss of mass which each particle undergoes. This is explained by the existence of the force of "nuclear attraction." Now it is true that like charges repel, and that the two protons (positive charges) in the helium nucleus should therefore fly apart. That they do not do so is due to the fact that nuclear particles are subject to the workings of two forces, the electrical force of repulsion of two like charges, and the force of nuclear attraction. The force of electric repulsion is a "long-range force"—that is, its effect upon particles is great when they are relatively *far apart*, growing weaker as the distance increases. The force of nuclear attraction is a "short-range force," having very great effect at *short distances*, and it is the preponderance of the force of nuclear attraction over the electric repulsion which holds the nucleus

together. When the nuclei of deuterium and tritium are brought sufficiently close by some external force, such as the heat of a thermonuclear reaction (for example, the explosion of a uranium bomb) the force of nuclear attraction exceeds the force of electric repulsion, and the particles of the two nuclei can regroup themselves (fuse) into a helium nucleus and a neutron.

Tritium and deuterium are chosen as ingredients for the hydrogen bomb because this mixture fuses faster than deuterium alone and liberates more energy, as our table (Slide II) shows. Deuterium can be made from ordinary water which contains one part of deuterium oxide per 5,000 of water. Tritium will have to be made, perhaps, by bombarding lithium with neutrons.

Let us now give a brief moment to the effects we can expect to produce by exploding a hydrogen bomb. Since we have been told that this bomb could be made 1,000 times as powerful as the uranium bomb, which destroyed all buildings within a radius of one mile, the hydrogen bomb would destroy all buildings within a radius of ten miles.

The blast effect alone could obliterate almost all of a city the size of New York, London or Moscow, etc. The fatal burn effects which were inflicted at Hiroshima over a territory of 5,000 feet from the point of explosion, and accounted for 30% of the casualties, would look very mild when compared with the destruction brought about by the hydrogen bomb, which would cause death burns at a radius of up to twenty miles. To statistics of blast and burn we must add the havoc wrought by the accompanying uranium bomb used in order to set the fusion process going. This older bomb would also do instantaneous damage in the form of lethal radiations, as well as producing death and illness of a delayed nature. (You will recall that the gamma rays and the neutrons released by a uranium bomb cause "radiation sickness" and death.) To these effects are added those brought about by the effect of the radioactive bomb-case particles and fission products upon the locality and the spreading effects of winds.

What defenses can we build against the hydrogen bomb? J. Robert Oppenheimer once remarked: "There are, and there will be, no specific counter-measures to atomic weapons." This would, of course, include the hydrogen bomb. In other words, we would be foolhardy to hope for some fantastic ray which would have the powers to explode such a bomb before its makers intended it to. Yet we could apply the usual tactics of trying to intercept the vehicles by which the bomb would be delivered, be they long-range bombers or submarines which might launch rockets containing the bomb. Detection of and timely defense against bombers would depend upon a great radar system. General George C. Kenney has stated that such a system "will be

exceedingly expensive to install, maintain and operate. The so-called airtight radar fence does not exist here or anywhere else." Even if we had the radar system, it would do us little good, unless we had a gigantic fleet of the very latest interceptor planes, so as to man every point of our defenses, around the clock daily. Furthermore, a war fought with such bombs would be a war rapidly-fought, and we would have to have our defenses ready. There could be no delaying action, while we prepared for war, as has been the case in the past.

An effective defense against the bomb would be to so spread our important industries, that one or several bombings would not put us out of the war. This will, of course, sound impractical or impossible. Yet it could be done in step-wise fashion. Assuming that we could have freedom from atomic war for about twenty years, we could bring about dispersal of our industries by compelling all factory owners or manufacturers of critical war materials to avoid using the old building sites whereever a new factory building was needed.

As to the protection of people living in large cities, we would have to resort to the same idea of dispersal. To form some conception of the size of the problem please note that ten cities in the northeastern United States have twenty-five million inhabitants, and ten states in this section have about sixty-five million people, almost half of our total population. If we were made the victims of a surprise attack, less than fifty bombs, efficiently distributed, could annihilate one quarter of our population. Proposals for dispersal of cities have carried with them the idea that if industrial plants were spread out, city populations, following the factory sites, would likewise spread out or disperse. The blessings which would follow are not limited to national defense. City dispersal would help solve other pressing problems, such as those produced by traffic congestion, existence of slums, organized crime, noise, air pollution, etc. Even if we did not disperse our cities it would be a great advantage not to allow them to grow above a size of one hundred thousand. Since about one third of our population today lives on less than one per cent of our area, the hydrogen bomb would do us great damage. If, on the other hand, we spread out and made use of our vast spaces, we would put to use our greatest ally against such weapons. We should also build up our disaster-relief potential, with all civilian defense machinery, shelters, emergency medical relief, training of personnel, fire fighting equipment, etc.

I shall close this talk with a discussion of the advantages and disadvantages to us of producing the hydrogen bomb:

It is argued that if we did not busy ourselves with the problem of making the hydrogen bomb, Russia would have done so, anyway. Thus, when Russia had the bomb and we did not, she would have had

us at a disadvantage. Furthermore, all weapons are horrible and the destruction of human life by making it vanish in a great flash is no more evil than destruction by older and more painful methods.

On the other hand, since Russia has only one or two cities large enough to be worthy targets for such a bomb, while we have ten or more, we stand to lose more than does Russia, should war be fought with hydrogen bombs. In addition, says this argument, six of our cities—Boston, New York, Philadelphia, Baltimore, Washington, and Los Angeles, all of target-size—are located on a coast, making it possible to attack them with hydrogen bombs launched rocketwise from a submarine, or to send the bomb to the target from an unmanned craft. Because Russian cities are not so located, we could not retaliate in this way. This argument assumes that radar would be successful in defending both countries.

It is also pointed out that since the certain and accurate delivery of a uranium bomb is so difficult, it would be better to spend our energy making improvements in the means of delivery rather than on making more powerful bombs.

Furthermore, the first side to use the hydrogen bomb could be accused of bringing about the end of our civilization, for with the destruction of our large cities, life would descend to a mere struggle for survival. With their disappearance would go our knowledge, industrial skills, and our morals and standards of human decency, with no hope of re-establishing them by the aid of our foreign friends, who benefited from our help when they were so situated after the last war.

It is also said that so large scale a weapon against civilians is a contradiction of our traditional American policy, which has always taken account of the value of human life.

Aside from psychological effects, the hydrogen bomb will probably not be more effective than ten uranium bombs upon a large target and than one uranium bomb upon a small one. Then why make the hydrogen bomb?

Other arguments which have been raised against the hydrogen bomb are that if we develop it, the Russians will have an easier time stealing the secret from us than having to do the research needed to make it themselves; that it is wrong to do anything which makes them feel that we are parading our strength in front of them; that our possession of the uranium bomb secret did not prevent Russia from expanding her boundaries after 1945 and before she had the uranium bomb.

Certain it is that some people think that the new bomb will make us secure because of its great power. This is not so. It is also certain that since tritium must be manufactured by the use of neutrons, that

making the hydrogen bomb will divert these from use in making plutonium, and therefore interfere with the manufacture of uranium bombs. Thus some writers have proposed as alternatives that we use our energies, instead, for the development of long-range guided missiles, and/or finding ways of defending our ships (carrying men and supplies to our battle-areas in foreign lands), against the hard-to-detect Schnorkel submarine.

The research scientist, however, must leave the complex problems of the moral, political and strategic aspect of the hydrogen bomb to others. Since this new weapon is now a possibility, it is a good thing for all of us to understand at least the basic theory of its construction.

BRIEF NOTES ON KINETIC ENERGY

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This inquiry gave rise to a very animated classroom discussion one day and the problem took on such intriguing complexion that I thought it worthwhile to present it in part, in the hope that students and teachers alike will find it academically interesting.

Suppose a ball is thrown from the hand with a velocity v feet per second. We instantly say that its kinetic energy is $\frac{1}{2}mv^2$, and this is also the work done in throwing it. Let us bear this last detail in mind. Since the initial kinetic energy was zero the *change* in kinetic energy is also $\frac{1}{2}mv^2$. Now suppose the thrower is in (on) a boat which is itself moving with a velocity v_1 feet per second and that the ball is thrown forward along the line of motion of the boat. If the ball still has a velocity v (relative now to the boat) the total velocity is $v+v_1$ and its kinetic energy is $\frac{1}{2}m(v+v_1)^2$. The *change* in kinetic energy is $\frac{1}{2}m(v+v_1)^2-\frac{1}{2}mv_1^2$. For any sensible velocities this change in kinetic energy is much greater than $\frac{1}{2}mv^2$. For example, take v as 30 ft/sec and v_1 as 20 ft/sec. Then $\frac{1}{2}mv^2$ is $450m$ and $mv(\frac{1}{2}v+v_1)$, which is the new difference or change in KE, is $1050m$. Clearly, the work *now* done in throwing the ball is *more than twice* our first figure, and we are led inescapably to the conclusion that it is more than twice as "difficult" to throw the ball while on the boat as it is on land! Is this not a dilemma?

(Lest I minimize the reader's satisfaction in resolving this dilemma and apparent paradox I refrain from suggesting the error in our argument.)

Arising now out of this first paradox is another. The first inquiry tells us that the kinetic energy of the ball is not $\frac{1}{2}mv^2$ but rather $\frac{1}{2}m(v+v_1)^2$. We came to this, you will recall, by invoking the boat's forward velocity v_1, since the ball before it was thrown had this velocity. But is this any more legitimate? We must answer *no*, for the earth's rotation gives the water a velocity v_2 say, and the energy must now be written $\frac{1}{2}m(v+v_1+v_2)^2$. But does not this lead us to add still other velocities since no frame of reference is at absolute rest? We now appear to be led to deeper dilemma—the *true* kinetic energy cannot be found.

It is hoped that this little note will incite some critical thinking on the part of students at least, and teachers too.

Needle threader, claimed usable for a blind person, is suitable for almost any type or size of thread and will thread either an ordinary or a sewing machine needle. A movable plunger revolves hand needles so that it can pass through the eye to catch a thread looped over the device.

SOME EXPERIENCES WITH SOIL FOR SCIENCE CLASSES

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There is an urgent need for an enlightened public in regard to soil conservation. To understand the problems related to soil conservation the person must have some ideas as to what constitutes this basic resource, soil. Probably the most effective method of acquiring knowledge of the resource is through real experiences with the resource.

The purpose of this article is, therefore, to suggest a few experiences with soil which may be used in high school science classes. It is difficult to suggest a grade level for each of these experiences since only the individual classroom teacher should be entrusted with this decision. The experiences were planned originally for high school biology. Nevertheless there may be eighth grade students who would profit from these experiences. It is possible also that some students might benefit most if these experiences were postponed until the students had reached their senior year.

The following experiences then are suggested as a means of gaining some first hand knowledge of soils:

1. Test for Soil Moisture—Collect a sample of soil in a one half-pint cardboard ice cream container. Weigh the soil plus the container. Place the container and its contents in a warm dry place. Stir the soil periodically over a period of two weeks. Weigh the soil and container again. Determine the weight of the empty container. Subtract the weight of the container from each of the previously determined weights. Subtract the dry weight of the soil from the wet weight of the soil. This is the loss of weight which is due to moisture. To determine soil moisture in per cent divide the loss of weight of the sample by the *dry weight* of the sample and multiply the resulting fraction by 100.

2. Test for pH—Hydrion paper gives a rough determination of pH. However, the teacher may purchase from commercial supply houses the necessary equipment for testing pH of the soil. With these kits a much more accurate determination of pH is possible.

3. Test for Organic Matter—There are complicated tests for soil organic matter such as the Schollenberger's test. These are not recommended for use at the high school level. The following test is satisfactory for use at this level since it is simple and in addition is fairly accurate. A sample of soil is taken. This soil is air dried for two weeks. During the two weeks' drying period, the soil should be stirred occasionally. A sample of the soil is added to a crucible and the weight

of the soil is determined. The covered crucible plus the soil is then heated in the flame of a bunsen burner for ten minutes. The weight of the soil is determined after the heating process is complete. The loss of weight of the soil divided by the dry weight of the soil before heating multiplied by 100 gives the per cent of organic matter.

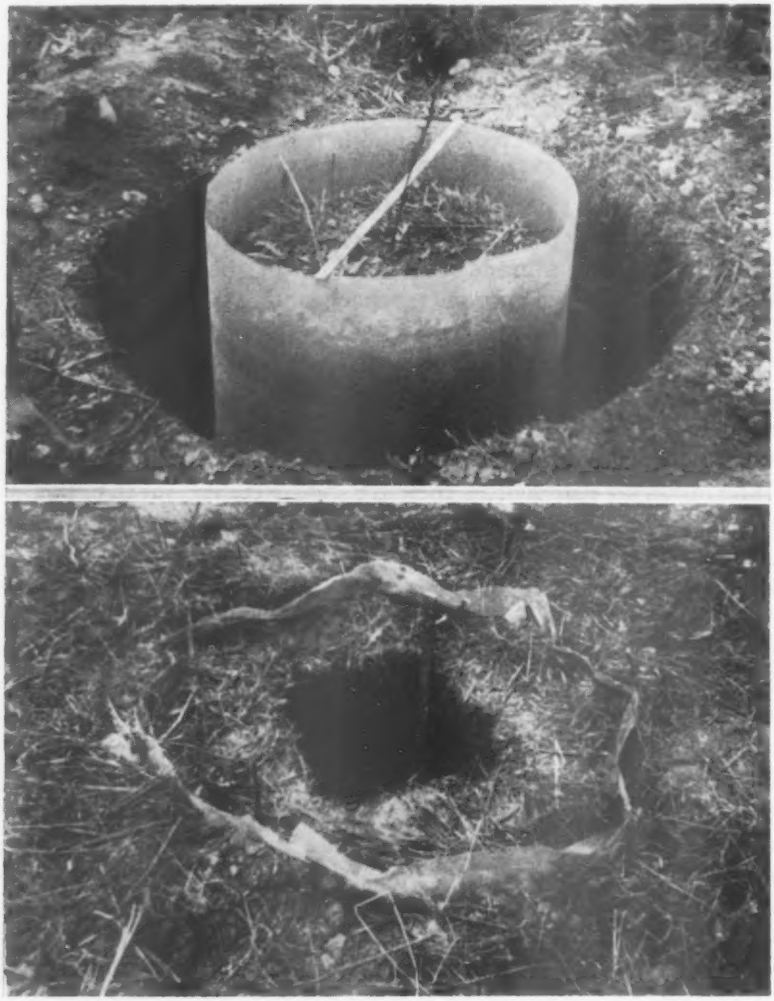

FIG. 1. Underground Terrarium. Upper photograph shows trench around central cylinder with plexiglass screening in place around the cylinder. Lower photograph shows trench filled and pit completed.

4. Test to Show That Soil Is a Mixture of Particles of Various Sizes—This is a simple test. The only equipment needed is screening of various sizes of mesh. Sometimes scraps of wire mesh screening may be obtained free from local hardware stores. The teacher should

procure a number of different sizes of wire mesh screening. These may be tacked to the bottom of small boxes from which the top and bottom have been removed. Soil samples are then placed on the screen and the screen is moved back and forth. Particles which are larger than the mesh of the screen are retained on the screen while smaller particles pass through. If a series of screens with various sizes of mesh are used the variety of sizes of soil particles within the sample will be demonstrated. It is then a simple matter to determine per cent by weight of the total sample for each particular particle size.

5. Observation of Soil Profile—To study the soil profile it is necessary to make a vertical cut into the soil in which the various upper layers of soil become visible. If an exposed bank is available it is advisable to make the cut at this location. However if a bank is not available, one may dig a hole to a depth of 12″ at any location where the soil profile is to be examined. The hole should be large enough so that the vertical cut forming the side of the hole is visible throughout its entire length. While the hole is being dug the increase in compactness of the soil with increasing depth will become evident. The difference in color of the topsoil and subsoil should also be noted. Along with these activities one may observe the types of root structures in plants and the depth of penetration of the roots. For guidance in these activities one may consult Lyon, T. L. and Buckman, H. D., *The Nature and Properties of Soils.*

6. Test to Demonstrate One of the Advantages Gained from Cultivation—Add equal weights of topsoil to two empty quart motor oil cans from which one end has been removed. Enough soil should be used to fill each can. Record the weights. Add 200 cc. of water to each can. Weigh the cans plus the soil and water and record the weights. Cultivate the soil in one can every day by moving a nail through the uppermost layer of the soil. This cultivation should be done to a depth of about 1″ and one should be sure that all of the surface layer has been thoroughly cultivated. Keep the second can as a control. Do not cultivate the soil in this case. Record the weight of the two cans each day. Any loss of weight will be due to loss of water by evaporation. After a few days it will be evident that cultivated soils lose less moisture than do soils which have not been so treated.

7. Test of the Water Absorbing Qualities of Soils—Use two empty quart motor oil cans for this experiment. Remove one end from each can. Punch holes in the opposite end. Fill one can with topsoil and the second can with subsoil. Place both cans with perforated ends down on top of quart glass fruit jars. Add water by sprinkling it slowly over the surface of the soil in the can containing subsoil. Continue this activity until water begins to percolate through the soil into the glass jar. This sprinkling process should not be hurried. De-

termine the volume of water used. Using an equal volume of water, repeat the process with the topsoil. Try to use the same amount of time for sprinkling in this case as was used in the case of the subsoil. During this process notice when water first begins to trickle through into the glass fruit jar. Leave the two motor oil cans in place over night. The following day measure the volume of water that has percolated through each type of soil. Now observe the soil in each can. Notice the consistency of each soil by removing some of each from the cans and crushing it between the fingers. Does the soil in either can feel savvy and sticky? Does the soil in the second can feel dif-

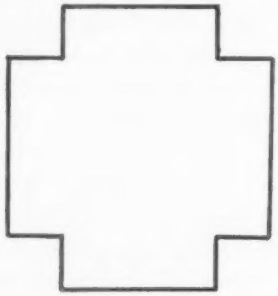

FIG. 2. Pattern for cutting $\frac{1}{4}''$ wire mesh for construction of terrarium tray.

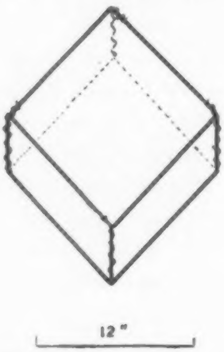

FIG. 3. Diagram of individual terrarium tray.

ferently? The teacher may repeat this experiment with many types of soils. In this manner some interesting comparisons are possible.

8. An Exercise Which Makes Possible the Study of Some of the Animals in the Soil—It would be difficult to study the microscopic animals of the soil as an activity for secondary school biology. However, those animals which we include in a portion of the life within the soil called the mesobiota make for interesting experimental material. In this group would be included members of the following classes: Oligochaeta, Crustacea, Chilopoda, Diplopoda, Arachnida, Insecta,

and Gastropoda. An experiment with the mesobiota of the soil was carried on by the author. For the purpose of the investigation, structures called Underground Terraria were constructed. The following procedure was carried out in their construction. In the soil a circular trench was dug with an inside diameter of 36″ and an outside diameter of 66″. Soil was removed to a depth of 32″. After the trench was completed, a cylinder of earth remained as the experimental plot. The dimensions of this cylinder were: circular cross-section, 36″ in diameter; height, 32″. The vertical surface of the cylinder was then covered with plexiglass screening and the trench was filled with soil. The pit for holding the trays in the Underground Terrarium was dug within the cylinder of earth referred to above as the experimental plot. This pit was square in cross-section. The intersection of the diagonals of the square coincided with the center of the circular cross-section of the cylinder. The pit was shaped as a rectangular solid. Its dimensions were 12″×12″×32″ (For photograph of trench and pit, See Figure 1).

Wire trays were constructed to be used as containers of soil in the Underground Terrarium. These trays (See Figure 2 and Figure 3) constructed of $\frac{1}{4}$″ wire mesh screening were each rectangular in cross-section. Each tray was constructed with a square base 12″ on a side and was 4″ in height. Since the pit was 32″ deep, eight trays were required. In order to maintain the soil layers in as near natural condition as possible, each 4″ layer of soil was placed in a large can. When returning the soil to the pit each time, it was necessary to tamp down each layer.

The procedure for filling the pits was as follows: One tray was lowered into the pit. It was filled with soil. A second tray was placed on the first. It too was filled. This procedure was followed until the pit was completely filled (For diagram of completed terrarium, see Figure 4).

After the construction of the Underground Terrarium was completed, it was necessary to allow the soil to settle for about one month. Then the wire trays were removed and the numbers and types of animals were recorded. In the case described here the device for lifting the lower trays from the pit was constructed in the following manner. Screen door hooks and eyes, clothesline, and lumber with dimensions, 1″×2″, were used in its construction. The four sides of the "lifter" (See Figure 5) were each 11″ long. Their ends were cut at 45° angles so as to increase the rigidity of the final product. The four sides were fastened together with screws. Two short pieces of lumber were put in place with screws across two of the opposite angles of the frame. This also afforded an increase in rigidity and stability to the lifter. Eight screweyes were then screwed into the frame. Each eye was

placed 3″ from the end of each of the sides. These served as loops for the clothesline. Four pieces of clothesline, each 21″ long, were cut. One piece of clothesline was threaded through the screweyes on one side of the frame. The two ends of this clothesline were fastened together securely with waxed twine. This procedure was followed on the remaining three sides of the frame. The four tied ends of clothesline were then fastened together by binding them with waxed twine. The

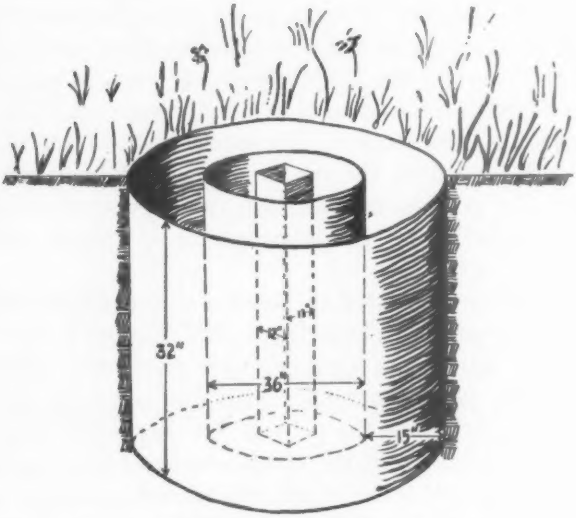

FIG. 4. Underground terrarium diagram.

FIG. 5. The Lifter. The device developed for removing the trays from the Underground Terrarium.

resulting structure then served as the handle of the "lifter." The screen door hooks were then screwed into the lower surface of the frame. Four hooks were placed in each of the four sides. When using the "lifter" the hooks were inserted into the openings of the $\frac{1}{4}$″ wire mesh screening. This made for a means of holding on to the wire trays while removing them from the pit.

After the soil organisms have been enumerated and identified, they are returned to the pit in the tray of soil from which they were taken. It is possible to remove the trays about once each month for re-examination.

From an investigation of soil organisms made in this manner, the student finds first that these organisms are found, in large part, near the surface. As depth increases there is a decrease in total numbers of organisms. This observation should foster a discussion as to why the greatest number of organisms are found in the uppermost layers of the soil. If this exercise is carried out over a period of months, the seasonal variation in number of organisms in the soil will also be demonstrated. This observation, too, should lead to some interesting discussion as to causes.

The foregoing discussion has been an attempt to suggest some activities for use in the study of soil. This is merely a beginning. Many other worthwhile activities are possible. It seems safe to assume that a greater knowledge of soil and its properties will be accompanied by a desire for its wiser utilization.

1952 READING INSTITUTE

The Ninth Annual Reading Institute at Temple University has been announced for the week of January 28 to February 1, 1952.

THEME: PREVENTION AND CORRECTION OF READING DIFFICULTIES

During this institute, the following sequence of topics will be discussed and demonstrated: (1) planning a reading program, (2) reading in a language arts setting, (3) evaluating achievement, progress, and capacity, (4) analysis of reading difficulties, (5) common difficulties in reading, (6) symptoms and causes of reading disabilities, (7) types of reading problems, (8) phonetics and word recognition, (9) semantic analysis and comprehension development, (10) reading skills and techniques, (11) directed reading and reading readiness activities, (12) differentiated instruction, (13) materials for developmental and corrective reading, (14) organization of corrective and remedial classes, and (15) speed reading.

Laboratory practice under competent supervision is provided in half-day sessions. Two sessions are scheduled for the construction of informal reading inventories and teaching plans for a directed reading activity. Other sessions, providing practice with children, deal with the following activities: (1) estimation of reading and hearing comprehension levels, (2) the identification of different types of reading disabilities, (3) the use of corrective and remedial techniques, (4) the evaluation of reading readiness, (5) speed reading, and (6) the detection of visual problems. All laboratory practice is differentiated for elementary, secondary, and college teachers.

Enrollment is limited by advance registration. For a copy of the program and other information regarding the Institute, write:

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NEWTON'S THIRD LAW*

M. W. Welch
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I ask permission to talk to the parents. The young men and women who are here are so much better taught than we were, are able to think so much more objectively, that I hesitate to speak to them, but to the parents, I do have something to say to them. I could not help but think as we examined these exhibits of the lines from Hamlet:

> "There are more things in Heaven and earth, Horatio,
> than are dreamt of in your philosophy."

How well these young people have taught us this lesson. There is nothing new under the sun. The whole gamut of electromagnetic radiations have existed from the beginning of time; every atom and every isotope, however short-lived has probably existed in nature, but historically, it was the youngsters little older than these youngsters who have discovered them, classified them, and made them the servants of mankind.

What has this to do with Newton's 3rd Law of Motion? Well, I'll get to that, but first, let us gather some data. Each year under Dr. Watson Davis of the National Academy of Science there is conducted a great science talent search among the high schools. It has been remarkable that the majority of the national prizes and scholarships have gone to New York. Occasionally, one jumps out to St. Louis but up to now, the City of Chicago has been only an also-ran. Are our children not as bright as they are in New York? Of course they are! It is the people of my generation who are at fault. It was my generation who up to a few short years ago tolerated and condoned the spoils system that ran rough shod over our schools. You are to be complimented that you insisted upon a change so that today you have school leadership of unquestioned integrity.

Here at this spring season we are particularly conscious of the difference between barren and fertile soil. You may sow your finest seed on barren land and it will never come to fruit. If you want plants to grow you must give them the environment for growth. If you want an understanding of science then provide an environment in which it may thrive.

None know that better than these Chicago teachers of physics. They have struggled with such meagre equipment, such overloading of paper work, such additional laboratory jobs, that I am amazed that they have provided this opportunity for your children in the first Chicago Science Fair. Every extra item that they have provided

* An address delivered at the First Chicago Science Fair.

for this splendid Fair is so much bread and meat from their tables.

What of New York you ask? Well let me urge that you go and call upon Dr. Morris Meister, nationally famous principal of the Science High School. Note that there is a high school specializing in Science. There you will find laboratories, equipment, and paid laboratory assistants that will do credit to the best of our colleges.

Well what about St. Louis? I have only mentioned these two out of a hundred cities. In St. Louis they have just finished their annual science fair. Over 25,000 people crowded into their week-long exhibit. $7,000 in scholarships was provided for the young people and more than $2,000 in cash prizes—and bear in mind that St. Louis is a city of less than a million people. What has all of this got to do with Newton's Third Law? I'm coming to that.

But bigness, equipment, and dollars are not all that make up the environment for the development of scientists. Do you realize where we are this evening. A poor boy was born in Springfield, Illinois in 1862. In 1917 he created a large fund and I quote from its purpose, "For the well-being of mankind"; then in 1929 Julius Rosenwald, that poor boy, gave this Museum of Science and Industry to Chicago, and I take it that this was for the well-being of mankind.

Just a few blocks to the west is Ryerson Laboratory of the University of Chicago and just a little farther on is Stagg Field. We all know it will not be remembered for the athletic contests that were held there but history will record that it was here that the first successful atomic pile was constructed and operated under the direction of an Italian citizen named Enrico Fermi. You and I and all the world should thank God that this did not happen at the University of Rome; for if it had, we and everyone else would by now, either have been dead or have been paying tribute to the tyrant of a new Roman Empire. Why didn't it come about in Rome? I have never asked Dr. Fermi. But I am sure that he would tell us that a big jowled dictator like Mussolini did not provide an environment conducive to scientific development. Do you realize that almost everyone of the great scientists whether they were Christians or Jews, Poles, Italians, Austrians, Frenchmen, Dutchmen or Danes, took the first opportunity to escape from the domination of the diabolical Hitler and Mussolini? Evidently then an essential ingredient for a scientific environment is freedom. That kind of freedom that recognizes that all men of every race and every kind are "endowed by their Creator with certain inalienable rights, that among these are life, liberty, and the pursuit of happiness."

What does all this have to do with Newton's 3rd Law of Motion. I am coming to that, but there is one other element that is essential to all scientific development. In a way it has been illustrated by the

conversations I have been hearing all afternoon. D. L. Barr has been saying, "One of my girls did this," and Phil Tapley has been saying, "One of my boys did that," and Mrs. Mary Schuman has referred to, "One of the projects of my group—." You can't help but feel it. Here is an interest on the part of both the student and the teacher that goes beyond the casual interest of inquisitiveness. It is that interest that is like the interest that a parent has in the activity of his child. It is the kind of interest that a child hungers for, it is the kind of interest that requires sacrifice, that intangible interest that is akin to love. That, too, is an essential ingredient to a truly scientific environment.

Oh yes, about Newton's 3rd Law! If I were to ask the young people here to define it they would shout back at me, "To every action there is always an equal and opposite reaction." Well, dear friends, that is exactly what I am talking about. Just in proportion as there is integrity, a feeling for the well-being for mankind, freedom, and love, there will be the reaction of scientific attainment. These teachers have provided these essential elements. Surely, it is our task to provide the opportunity.

I need not mention to these young people the old cliché—that you will get out of Physics exactly what you put into it.

Ladies and gentlemen, Chicago Physics teachers, girls and boys, and Sir Isaac Newton please forgive me.

SEARCH FOR NATION'S MOST PROMISING YOUNG SCIENTISTS

The annual search for the best potential scientists among the nation's high school seniors has begun, and students in public, private, and denominational schools throughout the United States have been invited to compete in the eleventh Science Talent Search.

Winners will share $11,000 in Westinghouse science scholarships. The boy or girl taking first place will receive a $2,800 scholarship, and 39 other finalists will vie for scholarships ranging from $2,000 to $100.

The Search is sponsored by the Westinghouse Educational Foundation, which is maintained by the Westinghouse Electric Corporation. It is conducted by Science Clubs of America—Watson Davis, director—through Science Service.

To enter the Search, students must report on an original science project and take a stiff science aptitude exam. Their schools must submit the students' scholastic records and teachers' estimates of their ability. Entries must be completed and received in Washington, D. C. by midnight Thursday, December 27, 1951.

The 40 outstanding boys and girls will be brought to Washington, D. C., next March for final judging, which will take place during a five-day Science Talent Institute. Scholarship winners will be announced at the conclusion of the Institute.

An additional 260 boys and girls who show promise of becoming creative scientists will receive honorable mention citations.

A SECOND LOOK

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Some score or more years ago beginning teachers were told, "Never place an incorrect form, word or statement before the learners." Learning after that pattern was remembering; dependable instruction required a perfect first impression.

However good such advice for teachers of beginners, even at that time there was agreement that, presently, the elementary pupils begin to need attention to understandings as well as remembering. These understandings involve a sense of fitness or the relatedness of things.

Getting skill in understanding could be acquired by exercises of correction as well as by positive exposition. For science such assignments may well seek both for practice in conscious attentiveness, the "Second Look," as well as constructive revision of that which is at fault. That which follows has three offerings: Absent Minded Set-ups, Word Boners, and Strange but True. These have in them an element of entertainment, which perhaps should not be discounted too greatly, as well as a possibility of more serious service.

ABSENT MINDED SET-UPS

Most teachers of chemistry have, before many years in their laboratories, come upon assemblies very near those diagrammed on the following page. A "Second Look" upon the part of the student would have corrected the mistake. Here they are presented for practicing the "Second Look." The first direction is: What is wrong with? (See Plate)

After a "Second Look" for the mistake the next logical act is in answer to: "How fix it?"

WORD BONERS[2]

The following are funny but the reason for their presentation here is for practice in using a "Second Look" for the one word or phrase, in each, which may be changed and by so doing the statement made correct.

In Pittsburgh they manufacture iron and steal.

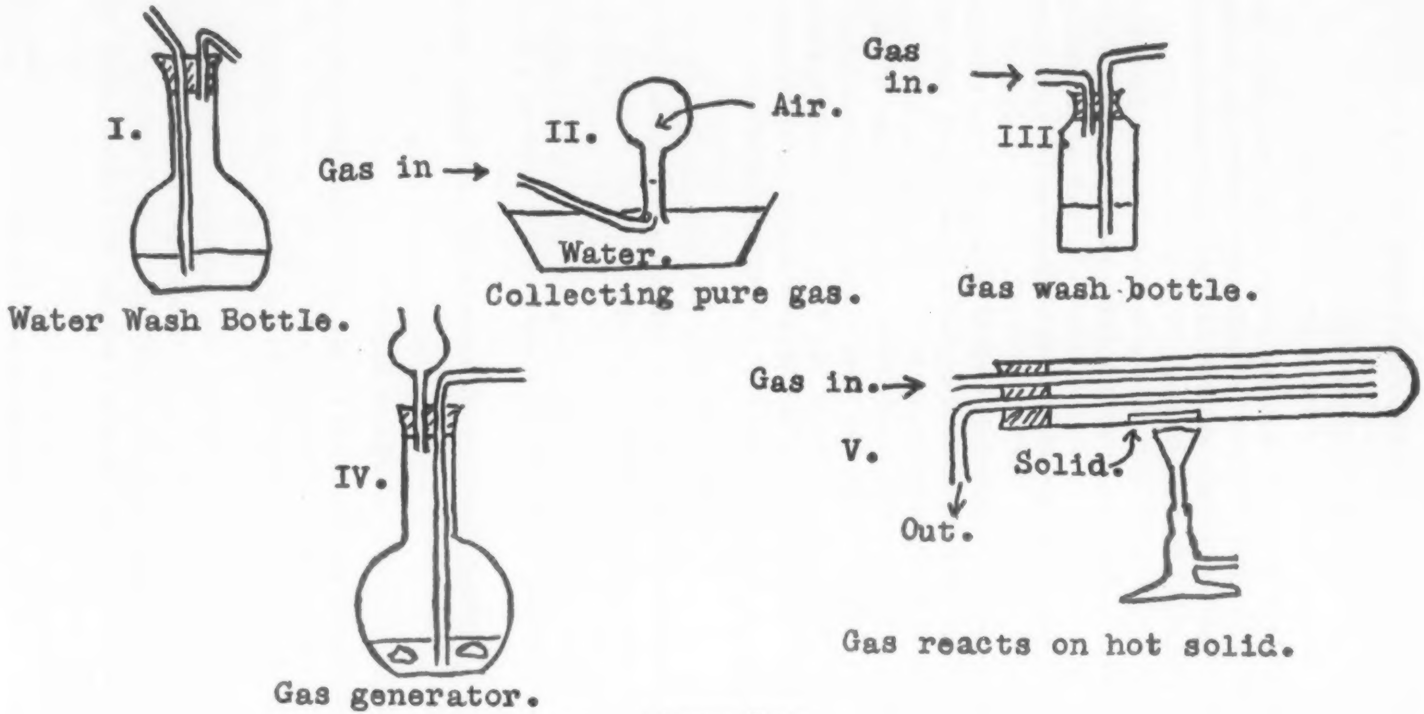
To purify water they filter it and then force it through an aviator.

The chief occupation of the inhabitants of Perth is dying.

If it had not been for Madame Curie and her husband there would be no radio today.

[1] Professor Emeritus.

[2] The Pocket Book of Boners. Number 110. Pocket Books Inc., New York.



A SECOND LOOK

To keep milk from turning sour you should keep it in the cow.

Gravity was discovered by Isaac Walton.

The process of turning steam into water again is called Conversation.

A liter is a nest of young puppies.

A magnet is the thing you find in a bad apple.

Sea water has the formula CH_2O.

An example of hard water is ice.

There are two kinds of thermometers: The Fahrenheit and the Centipede.

The metric system refers to: kilograms, centigrams and telegrams.

Tar is put on roofs to protect the weather.

When oxygen combines with anything heat is given off. This is known as constipation.

Glycerine is a vicious liquid, miserable in water in all proportions.

The digestive juices are bile and sarcastic juice.

Natural immunity is being able to catch a disease without the aid of a physician.

The earth makes a resolution every twenty-four hours.

Socrates died from an over dose of wedlock.

We used the antiseptic and were soon rid of the pessimist.

Hard water is bad for household use because it scratches the furniture.

I am not convinced. I'd take those figures with a dose of salts.

A thermometer is an instrument for raising temperance.

To collect fumes of sulfur, hold a deacon over a flame in a test tube.

Strange but True

How may we explain these statements which on "First Look," may appear to be wrong?

Sugar is an alcohol.

Soda water contains no soda.

Cadmium metal is a sort of neutron sponge.

The sun's heat is due to the synthesis of helium from hydrogen.

"Dry ice" boils before it melts.

There is no lead in a lead pencil.

Drying oils do not lose water as they dry.

Positrons and electrons both have weight but when they combine they produce weightless gamma rays.

"Fool's gold" contains no gold.

Aluminum can be eaten in bread that was baked in an aluminum pan.

You can not break hard water with a hammer.

There is more carbon dioxide in a cubic foot of lake water than in a cubic foot of air above it.

A cubic inch of the star called van Maanen weighs about ten tons.

Iron rust, hematite, is used by the farmer in barn paint, by my lady in her rouge and was used by the Indians in their war paint.

Mineral oil is not a mineral.

Fathers sometimes give their sons stones (rock salt and rock sugar) for food.

"Water gas" contains no water.

Air is less dense when it has water vapor added to it.

Fish gills do not remove constituent oxygen from water.

Laboratory manuals are prone to caution users to "look twice before writing the statement of what you have observed." Such a habit, even outside school room walls, would forestall many altercations that waste time and human energy. Maybe what is here presented may have worth to that end.

LOS ANGELES CITY COLLEGE

William B. Orange Mathematics Prize Competition

The competition was inaugurated as a memorial to the late William B. Orange, formerly Chairman of the Department of Mathematics of Los Angeles City College. It consisted of a two hour written examination held on May 25, 1951. Schools were permitted to send up to two teams of three students each, with a resulting total of 161 students from 33 high schools.

The team prize, won by Eagle Rock High School; with Dorsey High School a close runner-up; was a 40 inch bronze trophy. This trophy is to be presented annually to the winning school. A list of individual prize winners follows.

1. Tom Noonan—Eagle Rock High School
   $25 and Model 800 Pickett and Eckel Slide Rule
2. Eugene Murakami—Dorsey High School
   Model 2—Pickett and Eckel Slide Rule
   Kraitchik—Mathematical Recreations
3. Richard Read—Washington High School
   Model 500—Pickett and Eckel Slide Rule
4. Hiroshi Nakano—Belmont High School
   Model 600—Pickett and Eckel Slide Rule
5. Rodney Supple—Dorsey High School
   Model 1000—Pickett and Eckel Slide Rule
6. Dorothy Bowman—Fairfax High School
   Model 902—Pickett and Eckel Slide Rule
7. Dana Quade—University High School
   Subscription to Mathematics Magazine
   Copy of ***Mathematics Handbook***
8. Stanley Grotch—Hamilton High School
   Subscription to School Science and Mathematics Magazine
   Mathematics Handbook (Burington)

Does your journal reach you regularly? If not, please notify Mr. Ray C. Soliday, P. O. Box 408, Oak Park, Illinois.

SCIENCE INTERESTS OF JUNIOR HIGH SCHOOL PUPILS

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As part of a study carried on during the school year 1950–51,[1] the science interests of pupils in a sampling of three junior high schools in Denver were surveyed. A questionnaire was constructed using the current objectives of science teaching as a basis. A large number of science learnings, understandings, and outcomes were reviewed in order to select items to be included in the questionnaire. These statements were submitted to a jury of science teachers, and to a group of pupils for the selection of items most pertinent to the objectives of science teaching found in the literature. Using an average of rankings, 205 items were chosen for inclusion on the science interest questionnaire used. This was administered to a heterogeneous sampling of seventh, eighth, and ninth grade pupils in three junior high schools. These schools were selected on the basis of the general economic levels from which the pupils were drawn to give a better picture of average interests of pupils.

Two classes on each of the grade levels in each school were selected for this survey. The pupils surveyed were in general science classes at those levels. The total number of questionnaires returned from the schools was 486. These were distributed as shown in Table I. It will be seen that although the exact number of returns from each school varied, the total sampling from each level was about the same. The questionnaire was administered to the pupils in the three schools within the same period of time. All the questionnaires were distributed, marked by the pupils, and returned during January, 1951.

TABLE I. DISTRIBUTION OF PUPILS PARTICIPATING IN THE SURVEY OF SCIENCE INTERESTS IN THREE JUNIOR HIGH SCHOOLS IN DENVER, COLORADO

Name of School	Grade VII		Grade VIII		Grade IX	
	Boys	Girls	Boys	Girls	Boys	Girls
Cole	26	26	27	22	24	31
Lake	25	26	23	27	27	28
Smiley	34	31	24	25	27	33
Totals	85	83	74	74	78	92

The matter of how to treat the results of this questionnaire was given considerable thought. Several factors complicated the interpre-

[1] Sam S. Blanc, "Audio-Visual Resources for the Teaching of Science in the Junior High School," unpublished Doctor's dissertation, University of Denver, Denver, Colorado, 1951.

tation of the number of actual choices in the *Yes* and *No* columns on the form. The desired results were to be in terms of three grade levels with a separate interpretation for the boys and the girls. Therefore, it was felt that the raw scores could not be used directly. To obtain the type of interpretation desired, the percentages of the total cases in each grouping were used. After the number of pupils indicating a positive interest, and the number of pupils indicating a negative interest, in each of the items on the questionnaire were tabulated, the differences in per cents for each item in each group of pupils were computed. For example, using item 1 for the seventh grade boys, the following figure was obtained:

Total number of returns for seventh grade boys	85
Total number of checks in *Yes* column for item 1	23
Per cent of seventh grade boys marking *Yes*	27.04
Total number of checks in *No* column for item 1	39
Per cent of seventh grade boys marking *No*	45.88
Difference in per cent	−18.82

The difference in per cent might be in favor of the *Yes* answers, thereby indicating a positive interest in that item, or the difference might be in favor of the *No* answers, thereby showing a lack of interest in that item. Obviously, the greater the difference in per cent, whether positive or negative, the more significant the conclusions drawn for that item will be. If the difference in per cent between *Yes* and *No* scores for an item is negligible, then no real conclusions regarding the interest in that item may be drawn.

To determine a point at which the difference in per cent would have a statistical significance, the discussion on standard errors of proportions and per cents in sampling was consulted in Lindquist.[2] It was found that the following formula was applicable in this situation:

$$\sigma_p = \sqrt{\frac{pq}{N}}$$

in which σ_p is the standard error in the per cent, p is the per cent of *Yes* answers, q is the per cent of *No* answers, and N is the number of cases in the sample.

In making the interpretation from the data tabulated from the questionnaire, therefore, any difference in per cent between the total *Yes* and *No* answers that exceeded the significant difference in that respective group was considered statistically important. Any per cent difference that was less than this above figure was considered as due to chance only, and was, therefore, statistically insignificant.

From the standpoint of determining areas of interest it was felt

[2] E. F. Lindquist, *A First Course in Statistics* (Boston: Houghton Mifflin Company, 1942), pp. 125–129.

that it would be advantageous to regroup the 205 items on the questionnaire under main fields of organized science. Each item was, therefore, analyzed to determine in which field, and in which area within that field, it should be classed. After considering the implications of the whole list of items, it was possible to group them as shown in Table II.

TABLE II. DISTRIBUTION OF THE ITEMS ON THE QUESTIONNAIRE IN THE MAIN FIELDS AND AREAS OF SCIENCE

Main Fields of Science	Areas	Number of Items	Totals
Biological	1. Botany	10	
	2. Cells and Heredity	4	
	3. Ecology	10	
	4. Health	9	
	5. Hygiene	9	
	6. Nature Study	8	
	7. Physiology	8	
	8. Zoology	9	67
Physical	1. Astronomy	15	
	2. Atmosphere and Weather	11	
	3. Chemistry	7	
	4. Electricity and Magnetism	12	
	5. Geology	15	
	6. Hydraulics and Mechanics	7	
	7. Light and Sound	9	
	8. Matter and Energy	13	89
Social	1. Applications of Science	12	
	2. Conservation of Resources	12	
	3. Consumer Science	15	
	4. Superstitions in Science	10	49
Total			205

To show the composite interests of boys and girls separately in each of the twenty areas of science within the three major fields included, charts were constructed as shown in Figures 1 to 6. This was accomplished by averaging the significant degrees of positive interest (based upon the critical ratio for the five per cent level of significance in Lindquist)[3] for all items in one particular area of science. Since a high interest in all items in an area would produce a greater average figure than a low interest, the resulting computation became an indication of the over-all interest of the group of pupils in that area of science.

Bar graphs were constructed for each of these composite interests.

[3] Lindquist, *op. cit.*, p. 240.

To distinguish the three grade levels, 777777 was used for the seventh grade, 888888 was used to indicate the eighth grade, and 999999 was used for the ninth grade. Since each Figure shows the interests of boys and girls separately, the same method of distinguishing the three grade levels was used in each.

By glancing at each of the six Figures, the general interest in an area at each grade level, for boys and girls separately, may be determined. It appears, at first glance, that the interest level, in general, is low in all areas. However, it must be remembered, that only the *Significant Degrees of Interest* were averaged. Those interests which were not statistically significant were not included in the computation for these Figures. Those interests which do appear as bars are presumed to be real interests of a statistically significant nature. Even a bar extending out only to the first average degree of interest shows a real interest in that area for that grade level. Any value of less than

Area of Science	Average Degrees of Interest			
Botany	7			
Cells and Heredity	777777 888888 99999	777 8		
Ecology	777777 88 999			
Health	7777 888 999			
Hygiene	777777 88888 999999	777 99		
Nature Study	777777 888888 999999	777777 888	7	
Physiology	7777 888 99999			
Zoology	77777 8888			
	1	2	3	4

FIG. 1. Composite positive interest of boys in biological sciences.

one average degree of interest might be considered only as a slight interest, and any value which extends beyond two average degrees of interest should be considered as indicating a very high state of interest.

It must be recognized that the statistical technique employed does not allow for any interpretation of the degrees of interest except in a linear relationship. It can not be assumed that two degrees of interest are twice as significant as one degree. The degrees of interest merely indicate a relative measure of pupil interests. All that may be concluded from these bars is that a long bar indicates a higher degree of interest, than a short bar. Hence, the general profile of the Figure may be considered as a broad indication of the pupils' interests in that field of science. The farther the general outline of bars extends to the right, the higher the interest of pupils in that particular field which may be assumed. Figures 1 and 2 show the interests in the bio-

Area of Science	Average Degrees of Interest			
Botany	777777 88			
Cells and Heredity	777777 888888 999999	777777 888 999	7777	
Ecology	777777 888 999999	777		
Health	777777 8888 9999	777777	77	
Hygiene	777777 888888 999999	777777 88 9999	7777	
Nature Sturdy	777777 8888 9	77777		
Physiology	777777 8888 999999	777777 999		
Zoology	777777 8			
	1	2	3	4

FIG. 2. Composite positive interests of girls in biological sciences.

logical sciences, Figures 3 and 4 show the interests in the physical sciences, and Figures 5 and 6 show the interests in the social sciences.

Area of Science	Average Degrees of Interest			
Astronomy	777777 888888 9999	7 8		
Atmosphere and Weather	7777 8 9			
Chemistry	777777 888888 999999	777 888 99		
Electricity and Magnetism	777777 888888 999999	777777 888 999999	777777	
Geology	777777 888888 999999	77777 888		
Hydraulics and Mechanics	777777 888888 999999	777777 888888 999999	777777 9	77
Light and Sound	777777 888888 999999	777777 88888 99999	7777	
Matter and Energy	777777 8888 999	777		
	1	2	3	4

FIG. 3. Composite positive interests of boys in physical sciences.

In summarizing the results of this science interest questionnaire, it would seem that the pupils in the sampling in the three junior high schools studied are interested in the major areas of science as follows:

1. The field of biological sciences was of high interest to seventh grade girls and of good interest to seventh grade boys. Eighth grade pupils indicated a fair to good interest in all areas of this field except botany. Ninth grade pupils were interested in all areas except botany and zoology, with the girls displaying only a very slight interest in nature study.

2. The field of physical sciences was of very high interest to boys at all levels, and of fair interest to most girls. Seventh grade pupils

Area of Science	Average Degrees of Interest			
Astronomy	777777 888888 99999	77777 8888		
Atmosphere and Weather	777777 9	77		
Chemistry	777777 88 9999	7		
Electricity and Magnetism	777777 888 999999	7777 9999		
Geology	777777 888888 99999	77777		
Hydraulics and Mechanics	777777 888 999999	7		
Light and Sound	777777 888 999999	777777 9999		
Matter and Energy	777777 888 999	777		
	1	2	3	4

FIG. 4. Composite positive interests of girls in physical sciences.

Area of Science	Average Degrees of Interest			
Applications of Science	777777 88 99			
Conservation of Natural Resources	7777 8			
Consumer Science	7777 888 9			
Superstitions in Science	7777 8			
	1	2	3	4

FIG. 5. Composite positive interests of boys in social sciences.

Area of Science	Average Degrees of Interest			
Applications of Science	77777 888 99			
Conservation of Natural Resources	777777	7		
Consumer Science.	777777	777		
Superstitions in Science	777777 888	77		
	1	2	3	4

FIG. 6. Composite positive interests of girls in social sciences.

showed a good to high interest in all areas of this field. Eighth grade boys displayed a good to high interest in all the areas except atmosphere and weather, and eighth grade girls were especially interested in astronomy. The other areas were only of fair interest to girls on this level, with the area of atmosphere and weather drawing practically no interest. Ninth grade pupils showed a generally fair to good interest in all areas of this field except in atmosphere and weather.

3. The field of the social aspects of science showed a very low overall interest by either boys or girls compared to the two other fields included in the questionnaire. Only the seventh grade pupils indicated that they would be fairly interested in studying about all four areas in this field. The eighth grade boys showed only a slight interest in these four areas, while the girls at this level were slightly interested only in the applications and superstitions of science. The ninth grade group showed a definite negative pattern in almost every area in this field.

MATHEMATICS IN ASIAN SCIENTIFIC PERIODICALS

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In a previous article[1] the author has discussed the presence of mathematics in science articles found in certain periodicals of the American Physical Society and the American Chemical Society. It seemed of interest to compare the results with those obtained from a similar study of periodicals representing the chemists' and physicists' organizations in Asia. Asia was selected because of its reputation as a continent where the sciences are relatively undeveloped as compared with the Western Nations.

The choice of periodicals was governed by their availability in New York City. It was presumed, however, that those available would correspond with those of highest authority in the various fields, and indeed this seems to have been the case. All articles available were found to be in English, French, or German and hence presented no language difficulty. Language is relatively minor anyway in this investigation, as the mathematical symbolism is international. It was sufficient to be able to determine the subject-matter field of the article. A very few of the Indian articles were omitted because they were of a distinctly biographical or historical nature.

Scientific periodicals from India, Japan, China, and Thailand were obtained. These were almost entirely restricted to the second quarter of the Century, and except for India, were rather sparse or sporadic. This was especially true of some of the more recent issues from China and Japan. The journals from India were almost completely regular. The dates over which the periodicals were examined can be observed from the tables. It was found in all cases that the total number of articles was less than in the United States periodicals of similar dates. It was feasible, therefore, to include all research articles bearing on the subject under investigation from any volume examined. Only a sampling of volumes issued over the periods indicated was selected, however; although in the case of Japan, it was necessary to use nearly everything at hand as the Japanese journals are decidedly sparse and have a tendency to publish articles which are extremely lengthy but few in number. Much of the Japanese physical and chemical research appears to be announced only in the form of abstracts of a few sentences. These were not used in this study. For the Indian periodicals, sampling was done by selecting volumes either 5 or 10 years apart.

[1] Bergen, Catharine, "The Prevalence of Mathematics in Science from 1900 to 1950." SCHOOL SCIENCE AND MATHEMATICS, LI (June 1951), 443–446.

The periodicals examined are listed below and assigned a number which serves to identify them in the tables.

1. *Proceedings of the Indian Academy of Sciences*—Section A (only physics and physical chemistry articles were selected—mathematics and organic chemistry are also included in this publication).
2. *Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science.*
3. *Japanese Journal of Physics-Transactions.*
4. *Chinese Journal of Physics.*
5. *The Physical Review.*
6. *Indian Chemical Society Journal.*
7. *Japanese Journal of Chemistry-Transactions.*
8. *Journal of the Chinese Chemical Society.*
9. *Journal of the American Chemical Society.*
10. *Thai Science Bulletin.*

Both Japanese journals are organs of the National Research Council of Japan. The *Thai Science Bulletin* is put out by the Department of Science of the Ministry of Economic Affairs of Bangkok.

The issues of the *Thai Science Bulletin* from November 1937 to October 1940 were studied but no evidence of any use of mathematics other than numerical data was detected. Only 3 articles that could be called chemistry and 1 in soil physics were found over the 3 year period. There were a number of articles on agriculture and biology which were not counted, although the author is reasonably sure that these, too, were not mathematical in nature. It will be evident to the reader why Thailand was omitted from the table below.

The results from the physics articles are presented in Table 1. It

TABLE 1. ANALYSIS OF PHYSICS ARTICLES

Nation	Periodical	Dates	Total number physics articles	Number of articles with mathematics	Percentage of articles with mathematics
India	1	1935–'49	233	137	58.9%
India	2	1930–'47	152	91	59.8
Japan	3	1922–'35	49	31	63.3
China	4	1933–'40	50	38	76.0
				Asian average	64.5%
United States	5	1930–'50	60	41	68.3%

will be noted that the percentage of articles involving mathematics for Asian countries varies only from about 59% to 76%. The Asian average is only slightly lower than that of a sampling of articles from the *Physical Review* (United States) for similar dates. It is not thought that the difference is significant. When the mathematical articles were separated into those involving the calculus or higher mathe-

matics and those involving only algebra and trigonometry, it was found that more than half of the United States group involved the calculus but less than half of the Asian group made any use of this. In addition 17 of the Asian articles (mostly Indian) involved mathematics only to the extent of the statement of a single equation used for calculating purposes. Expressions for determining energy level differences in connection with spectroscopy were not counted. India especially has produced a number of such articles.

Also in connection with Table 1, it is interesting to note the similarity of the percentages from each of the two periodicals of India. Apparently each periodical attracts a similar type of article from the mathematical point of view.

Table 2 outlines the results from the chemistry articles. Since organic and general as well as physical chemistry is included, one would expect the lower percentage figures for mathematics, which one in fact finds. Chemical equations and expressions for the determination of equilibrium constants in terms of active masses or concentrations were not counted as mathematics. Here as in physics, the Asian and United States percentages differ only slightly. Here also 18 of the Asian articles (again mostly Indian) contain no mathematics except an equation used for calculating purposes. It is likely that these articles can be grasped by one not versed even in algebra, although no doubt most of the actual readers are familiar with mathematics.

TABLE 2. ANALYSIS OF CHEMISTRY ARTICLES

Nation	Periodical	Dates	Total number of chemistry articles	Number of articles with mathematics	Percentage of articles with mathematics
India	6	1925–'50	411	59	14.4%
Japan	7	1922–'28	29	7	24.1
China	8	1933–'40	118	17	14.4
				Asian average	17.6%
United States	9	1930–'49	795	106	13.4%

It can be concluded that Asian scientific research is not suffering in quality, although there is less of it. Sir C. V. Raman of India and Dr. Yukawa of Japan, in fact, are well-known as Nobel Prize Winners in physics. The author spent some time observing names of Indian scientists and noticed quite a frequent repetition of names. Apparently the number of individual scientists is not too large. This is not unexpected, of course.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Missouri

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

Late Solutions

2251, 4, 5. *Leon Bankoff, Los Angeles.*

2257. *Proposed by Cecil B. Read, Wichita, Kans.*

If $A+B+C=180°$, prove that

$$\cot A+\cot B+\cot C=\cot A \cot B \cot C+\csc A \csc B \csc C.$$

Solution by W. R. Talbot, Jefferson City, Missouri

If we place all the cotangents in the left member and change all functions to sines and cosines, our problem is equivalent to proving

$$\cos A \sin B \sin C+\sin A \cos B \sin C+\sin A \sin B \cos C-\cos A \cos B \cos C=1.$$

In the left member we may combine the first and last terms and the second and third terms to get

$$-\cos A \cos (B+C)+\sin A \sin (B+C)=1.$$

Since $\cos (B+C)=-\cos A$ and $\sin (B+C)=\sin A$, we get the true relation

$$\cos^2 A+\sin^2 A=1.$$

Other solutions were offered by: George Janicki, Chicago; Robert L. Morrison, White Plains, N. Y.; Max Beberman, Urbana, Ill.; Martin Hirsch, Brooklyn; David Rappaport, Chicago; Charles McCracken, Jr., University of Cincinnati; Hugo Brandt, Chicago; Paul J. Malie, Hickory, Pa.; James R. Fenwick, Harvey, Ill.; Mrs. Rosa W. Blackwell, Birmingham, Ala.; C. W. Trigg, Los Angeles City College; Walter R. Warne, Shurtleff College, Alton, Ill.; Nicholas Kushta, Arlington Heights, Ill.; Charles Salkind, Brooklyn; W. J. Cherry, Berwyn, Ill.; Dwight Foster, Florida A&M College; Leon Bankoff, Los Angeles; John Egsgard, Toronto, Ont., Canada; and by the proposer.

2258. *Proposed by C. W. Trigg, Los Angeles City College.*

Show that

$$\sum_{i=1}^{n}(-1)^{i+1}i^2=(-1)^{n+1}\sum_{i=1}^{n} i.$$

Solution by the proposer

We use the identity $a^2-b^2=(a+b)(a-b)$.
If n is odd, then

$$\begin{aligned}\sum_{i=1}^{n}(-1)^{i+1}i^2&=1-4+9-16+25-\cdots-(n-1)^2+n^2\\&=1+(3+2)(3-2)+(5+4)(5-4)+\cdots+[n+(n-1)][n-(n-1)\\&=1+2+3+4+5+\cdots+(n-1)+n=(-1)^{n+1}\sum_{i=1}^{n} i.\end{aligned}$$

If n is even, then

$$\begin{aligned}\sum_{i=1}^{n}(-1)^{i+1}i^2&=1-4+9-16+\cdots+(n-1)^2-n^2\\&=(1+2)(1-2)+(3+4)(3-4)+\cdots+(n-1+n)(n-1-n)\\&=-[1+2+3+4+\cdots+(n-1)+n]=(-1)^{n+1}\sum_{i=1}^{n} i.\end{aligned}$$

Solutions were also offered by: L. H. Lange, Valparaiso, Ind.; Leon Bankoff, Los Angeles; W. J. Cherry, Berwyn, Ill.; Hugo Brandt, Chicago; Charles Salkind, Brooklyn; Charles McCracken, Jr., University of Cincinnati; Edward S. Gorham, San Francisco; Max Berberman, Urbana, Ill.; Roy Wild, Moscow, Idaho; W. R. Talbot, Jefferson City, Mo.

2259. *Proposed by Dwight L. Forster, Florida A & M College.*

Eliminate θ between $m=\csc\theta-\sin\theta$ and $n=\sec\theta-\cos\theta$ and show that $m^{2/3}+n^{2/3}=(mn)^{-2/3}$

Solution by Paul J. Malie, Hickory, Pa.

$$m=\csc\theta-\sin\theta=\frac{1-\sin^2\theta}{\sin\theta}=\frac{\cos^2\theta}{\sin\theta}\tag{1}$$

$$n=\sec\theta-\cos\theta=\frac{1-\cos^2\theta}{\cos\theta}=\frac{\sin^2\theta}{\cos\theta}\tag{2}$$

$$\begin{aligned}m^{2/3}+n^{2/3}&=\frac{\cos^{4/3}\theta}{\sin^{2/3}\theta}+\frac{\sin^{4/3}\theta}{\cos^{2/3}\theta}\\&=\frac{\cos^2\theta+\sin^2\theta}{(\sin\theta\cos\theta)^{2/3}}=\frac{1}{(\sin\theta\cos\theta)^{2/3}}.\end{aligned}\tag{3}$$

Using (1) and (2)

$$mn=\frac{\cos^2\theta}{\sin\theta}\cdot\frac{\sin^2\theta}{\cos\theta}=\sin\theta\cos\theta.\tag{4}$$

Therefore (3) becomes

$$\frac{1}{(mn)^{2/3}}\quad\text{or}\quad(mn)^{-2/3}.$$

Other solutions were offered by: Hugo Brandt, Chicago; W. R. Talbot, Jefferson City, Mo.; Martin Hirsch, Brooklyn; Oliver T. Shannon, Wheeling,

W. Va.; George Janicki, Chicago; Max Berberman, Urbana, Ill.; James R. Fenwick, Harvey, Ill.; V. C. Bailey, Evansville, Ind.; C. W. Trigg, Los Angeles City College; Charles Salkind, Brooklyn; W. J. Cherry, Berwyn, Ill.; Leon Bankoff, Los Angeles; and the proposer. Archie Gammell, Chatfield, Minn.; Martha Hoagland, Hopkins, Minn.

2260. *Proposed by Hugo Brandt, Chicago, Illinois.*

A crop of p objects is gathered by n people by sunset. In the night each person in turn, unnoticed by the others, discards one object (to make the pile divisible by n), takes from the pile $1/n$ of it and hides it. In the morning after one object is discarded, the pile is divisible into n equal parts, each one's share being s. Find the smallest p and s in terms of n.

Solution by W. R. Talbot, Jefferson City, Missouri

The amounts in the pile after the several discards and hiding of shares may be indicated as follows:

After discarding	After hiding share
$p-1=k_0n$	$k_0(n-1)$
$k\ (n-1)-1=k_1n$	$k_1(n-1)$
$k_2(n-1)-1=k_2n$	$k_2(n-1)$
$\vdots$	$\vdots$
$k_{n-1}(n-1)-1=sn$	

where each k is the quotient obtained when the amount in the pile is divided by n. We may relate p and s by eliminating successive values of k in the discard column.

$$p=k_0n+1=\frac{n^2(k_1+1)-(n-1)^2}{(n-1)}$$

and eventually

$$p=\frac{n^{n+1}(s+1)-(n-1)^{n+1}}{(n-1)^n}.$$

To make p integral, it is necessary that $s+1=c(n-1)^n$ where c is an integer. To make s and p be least, we set $c=1$ and get

$$s=(n-1)^n-1$$
$$p=n^{n+1}-n+1.$$

Other solutions were offered by: Max Beberman, Urbana, Ill.; and the proposer.

2261. *Proposed by Ralph E. Eckstrom, Fulton, Mo.*

If the arc AB of a circle is 20 and the chord is 16, find the radius.

Solution by V. C. Bailey, Evansville College, Evansville, Ind.

If 2θ is the central angle subtended by the chord, then

$$r=\frac{10}{\theta}=\frac{8}{\sin\theta}. \tag{1}$$

$$\theta=5/4\sin\theta. \tag{2}$$

By the method of iteration

$$\theta=1.1295 \text{ approximately.} \tag{3}$$

Then

4) $$r=\frac{10}{\theta}=8.8535.$$

Other solutions were offered by: W. R. Talbot, Jefferson City, Mo.; Leon Bankoff, Los Angeles; Dwight Foster, Florida A & M College; F. A. Lee, Williamsburg, Va.; Max Beberman, Urbana, Ill.; Martin Hirsch, Brooklyn; and the proposer.

2262. *Proposed by Doris Crane, Chatfield, Minn.*

If $$\frac{\cos\theta}{a}=\frac{\sin\theta}{b}\quad\text{prove that}\quad\frac{a}{\sec 2\theta}+\frac{b}{\csc 2\theta}=a.$$

Solution by Leon Bankoff, Los Angeles.

$$\frac{\cos\theta}{a}=\frac{\sin\theta}{b}$$

$$b\cos\theta=a\sin\theta$$

$$b\cos\theta\sin\theta=a\sin^2\theta$$

$$b\left(\frac{\sin 2\theta}{2}\right)=a\left(\frac{1-\cos 2\theta}{2}\right)$$

$$b\sin 2\theta=a-a\cos 2\theta$$

$$a\cos 2\theta+b\sin 2\theta=a$$

$$\frac{a}{\sec 2\theta}+\frac{b}{\csc 2\theta}=a.$$

Other solutions were offered by: Dwight Foster, Florida A & M College; Max Beberman, Urbana, Ill.; J. C. Egsgard, Toronto; W. R. Talbot, Jefferson City, Mo.; Martin Hirsch, Brooklyn; Oliver T. Shannon, Wheeling, W. Va.; George Janicki, Chicago; Robert Morrison, West Plains, N. Y.; David Rappaport, Chicago; Burton G. West, Port Arthur, Texas; V. C. Bailey, Evansville, Ind.; C. W. Trigg, Los Angeles City College; Charles McCracken, Jr., University of Cincinnati; Nicholas Kushta, Arlington, Ill.; Leonard F. Leamy, Worcester, Mass.; Charles Salkind, Brooklyn; Walter R. Warne, Alton, Ill.; Vance Crane, East Uarick, N. Y.; and the proposer.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

PROBLEMS FOR SOLUTION

2275. *Proposed by V. C. Bailey, Evansville, Indiana.*

In triangle ABC, if $1-\cos A$, $1-\cos B$, $1-\cos C$ are in harmonic progression, show that $\sin A$, $\sin B$, $\sin C$ are in harmonic progression.

2276. *Proposed by V. C. Bailey, Evansville, Indiana.*

If x, y, z are distances of centers of escribed circles of a triangle ABC, from center of in-circle and d is the diameter of the circum-circle, show that

$$xyz+d(x^2+y^2+z^2)=4d^3.$$

2277. *Proposed by Dwight L. Foster, Florida A & M College.*

If $s=a+b+c$, prove that

$$(as+bc)(bs+ca)(cs+ab)=(b+c)^2(c+a)^2(a+b)^2.$$

2278. *Proposed by C. W. Trigg, Los Angeles City College.*

Show that there is no scale of notation in which the three digit number, $aaa=a^3$.

2279. *Proposed by Norman Anning, University of Michigan.*

In triangle P_1, P_2, P_3, r is radius of incircle, also r_1, r_2, r_3 are radii of excircles inside angles P_1, P_2, P_3 respectively. Show that the following relations hold:

If	$P_3=60°$,	$3r_3=3r+r_1+r_2$	and	$3rr_3=r_1r_2$
and if	$P_3=90°$,	$r_3=r+r_1+r_2$	and	$rr_3=r_1r_2$,
also if	$P_3=120°$,	$r_3=r+3r_1+3r_2$	and	$rr_3=3r_1r_2$.

2280. *Proposed by Norman Anning, University of Michigan.*

Using same notation as in 2279, find angle P_1 if $2r_1=2r+r_2+r_3$.

BOOKS AND PAMPHLETS RECEIVED

College Mathematics, A First Course, Second Edition, by W. W. Elliott, *Professor of Mathematics, Duke University*, and Edward R. C. Miles, *Research Contract Director, Institute for Cooperative Research, The Johns Hopkins University*. Cloth. Pages xii+436. 15×23 cm. 1951. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $4.85.

Nutrition for Health, by Holger Frederick Kilander, *Specialist for Health Education in the United States Office of Education*. Cloth. Pages xvi+415. 13.5 ×21.5 cm. 1951. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $3.00.

Statistical Methodology Reviews 1941–1950, Edited by Oscar Krisen Buros, *Director, Institute of Mental Measurements, School of Education, Rutgers University*. Cloth. Pages x+457. 19×27 cm. 1951. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $7.00.

Introduction to Number Theory, by Trygve Nagell, *Professor of Mathematics, University of Uppsala, Sweden*. Cloth. 309 pages. 15×23 cm. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.00.

Numbers in Action, Teacher's Edition, by Maurice L. Hartung, Henry Van Engen, and Catharine Mahoney. Cloth. 288 pages. 20×25 cm. 1951. Scott, Foresman and Company, 433 East Erie Street, Chicago 11, Ill.

The Wonderworld of Science. Books One, Two and Three, by Warren Knox, George Stone, Morris Meister and Doris Noble. Book One, 136 pages. Book Two, 168 pages. Book Three, 200 pages. Books Four, Five and Six, by Warren Knox, George Stone, Morris Meister and Dorothy Wheatley. Book Four, 232 pages. Book Five, 264 pages. Book Six, 296 pages. Books Seven and Eight, by Morris Meister, Ralph E. Keirstead, and Lois M. Shoemaker. Book Seven, 360 pages. Book Eight, 360 pages. All book are cloth. 14×19.5 cm. 1950. Charles Scribner's Sons, 597 Fifth Avenue, New York 17, N. Y.

College Mathematics, by Charles E. Clark, *Associate Professor of Mathe-*

matics, Emory University. Cloth. Pages v+331+46. 15×23 cm. 1950. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y.

PLANE TRIGONOMETRY WITH TABLES, Third Edition, by Lyman M. Kells, Ph.D., *Professor of Mathematics;* Willis F. Kern, *Associate Professor of Mathematics* (Retired); and James R. Bland, *Professor of Mathematics*. All at the United States Naval Academy. Cloth. Pages xi+220+vii+118. 15×23 cm. 1951. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $3.50.

EXHIBIT TECHNIQUES, Edited by Helen Miles Davis. Cloth. 112 pages. 13×19.5 cm. 1951. Science Service, Inc., 1719 N Street, N.W., Washington 6, D. C. Price $2.00.

HOW BIG? HOW MANY? Arithmetic for Home and School, by Gladys Risden, Ph.D., *Child Psychologist and Former Teacher*. Cloth. 248 pages. 13×20 cm. 1951. Christopher Publishing House, 1140 Columbus Avenue, Boston 20, Mass. Price $3.50.

THE ARITHMETIC OF BETTER BUSINESS, by Frank J. McMackin, President, *Jersey City Junior College, Jersey City;* John A. Marsh, *Former Head of Mathematics Department, High School of Commerce, Boston;* and Charles E. Baten, *Head of Commercial Department, The Lewis and Clark High School, Spokane*. Cloth. Pages viii+389. 15×23 cm. 1951. Ginn and Company, Statler Building, Boston 17, Mass. Price $2.48.

EVERYDAY GENERAL MATHEMATICS, Book Two, by William Betz, *Specialist in Mathematics, Rochester, New York;* A. Brown Miller, *West Technical High School, Cleveland, Ohio;* F. Brooks Miller, *Formerly Shaker Junior High School, Shaker Heights, Ohio;* Elizabeth B. Mitchell, *Charlotte High School, Rochester, New York;* and H. Carlisle Taylor, *Head of the Department of Mathematics, Benjamin Franklin High School, Rochester, New York*. Cloth. Pages ix+438. 15×23 cm. 1951. Ginn and Company, Statler Building, Boston 17, Mass. Price $2.60.

DISCOVERING ARITHMETIC, Book 1, by Catherine Stern. Teacher's Edition. Paper. 128 pages. 20×28 cm. 1951. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $1.60.

BILLY BASS, by R. W. Eschmeyer. Cardboard. 47 pages. 12×17 cm. 1951. The Fisherman Press, Inc., Oxford, Ohio.

OUR CHICAGO PUBLIC SCHOOLS. Annual Report of the General Superintendent, Chicago Public Schools 1950–51. Paper. 48 pages. 21.5×28 cm. Chicago, Ill.

OFFERINGS AND ENROLLMENTS IN HIGH-SCHOOL SUBJECTS. Biennial Survey of Education in the United States, 1948–50. Chapter 5 by J. Dan Hull and Others. Paper. Pages vi+118. 14×23.5 cm. Superintendent of Documents, U. S. Printing Office, Washington 25, D. C. Price 30 cents.

THE CROP THAT DID NOT FAIL. (In form of a Comic Book) 15 pages. 18×25.5 cm. 1951. International Paper Company, Southern Kraft Division, Mobile 9, Ala.

VITALIZING SECONDARY EDUCATION. Report of The First Commission on Life Adjustment Education for Youth. Bulletin 1951, No. 3. Pages vi+106. 14×23.5 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 30 cents.

DESIGN, CONSTRUCTION AND OPERATING PRINCIPLES OF ELECTROMAGNETS FOR ATTRACTING COPPER, ALUMINUM AND OTHER NON-FERROUS METALS, by Leonard R. Crow, *Educational Specialist in Development of Electrical Instruction, Director of Research and Development of Universal Scientific Company, Inc.* Paper. 38 pages. 14×21.5 cm. 1951. The Scientific Book Publishing Company, 530 South Fourth Street, Vincennes, Ind. Price $1.00 paper bound, $1.25 cloth bound.

THE ACTIVITY PERIOD IN PUBLIC HIGH SCHOOLS, by Ellsworth Tompkins, *Specialist for Large High Schools.* Bulletin 1951, No. 19. Pages v+17. 14.5×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 15 cents.

NOTES ON THE THEORY OF PROGRESS, by Leland Mathis. Paper. Pages ii+63. 14×21.5 cm. 1951. Pine Avenue Publisher, Riverside, Ill. Price $1.00.

ANTHOLOGY IN EDUCOLOGY, by Lowry W. Harding, *Curator.* Paper. Pages xv+78. 13.5×22 cm. 1951. Wm. C. Brown Company, Dubuque, Iowa. Price $1.50.

RESIDENCE AND MIGRATION OF COLLEGE STUDENTS, 1949–50, by Robert C. Story, *Head, Technical Services Unit, Research and Statistical Standards Section.* Paper. Misc. No. 14. Pages vi+61. 23×29 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 35 cents.

SCHOOLS FOR OUR TIMES. Annual Report of the Profession to the Public by the Executive Secretary of the National Education Association of the United States. Willard E. Givens. Paper. 15 pages. 22×28 cm. 1201 Sixteenth Street, N.W., Washington 6, D. C.

FRUSTRATION IN ADOLESCENT YOUTH, by David Segel, *Specialist in Tests and Measurements.* Bulletin 1951, No. 1. Pages vi+65. 14.5×23.5 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 25 cents.

THREE KEYS TO STRENGTH—PRODUCTION, STABILITY, FREE WORLD UNITY, by the Director of Defense Mobilization, Charles E. Wilson. Third Quarterly Report to the President. Pages iv+48. 20×26 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 30 cents

BOOK REVIEWS

1. METHODS AND ACTIVITIES IN ELEMENTARY-SCHOOL SCIENCE, by Glenn O. Blough, *Specialist in Elementary Science, U. S. Office of Education,* and Albert J. Huggett, *Associate Professor of Education, Michigan State College.* Pages 310. Dryden Press, New York. Price $3.75.
2. ELEMENTARY-SCHOOL SCIENCE AND HOW TO TEACH IT, by Blough and Huggett. Pages 544. Dryden Press, New York. Price $5.25.

The sincerity, inimitable humor, and sound pedagogy so characteristic of Glenn Blough's teaching and writings are distinctive features of the two publications for science teachers recently released by the Dryden Press. The two authors who have collaborated in writing these books have an excellent background of experience in elementary education and in elementary science in particular. Dr. Glenn O. Blough, Specialist in Elementary Science for the United States Office of Education, is a co-author of the well-known series of science texts, "Discovering Our World," and has had considerable experience in teaching

elementary science, both to children and to student teachers. Dr. Albert J. Huggett, the companion author, is Associate Professor of Education at the School of Science and Art, at Michigan State College.

These two men, from their rich background of knowledge and experience, have produced two books which will be sources of immense value to all who wish to help boys and girls with their science discoveries.

The earlier publication, "Methods and Activities in Elementary Science," is especially helpful to the teacher who may have a background of science information, but who does not know how to teach science to children. In this book he will find ways to stimulate children to raise questions and then to find their own answers. He will also find simple experiments to be performed with dime-store equipment or with simple science kits, suggestions for developing the ability to observe and investigate in a scientific way. He will learn how to develop scientific methods at the level of the young child. In fact, if the teacher follows the suggestions for carrying on any one of the units described in this volume, he will be convinced that science can be fun for both teacher and pupils.

The second volume, "Elementary School Science and How to Teach It," accomplishes two objectives: presenting the necessary scientific facts and principles together with successful methods for teaching them. The teacher whose own science background is so sketchy that he fears to tackle science teaching will appreciate this book.

The organization of the material is interesting and novel. Beginning with a section on fundamental principles of teaching science to children, the authors then proceed to explore three major areas: the earth and the universe, living things, and matter and energy. These areas are broken down into smaller teaching units, for each of which there is an "A" and a "B" chapter. In the "A" part, the subject matter of the unit is presented; in the "B" part, how to teach it. What could be more useful to the beginning teacher of elementary school science or to student teachers in training?

The wise teacher will buy and use both books, since they do not duplicate but rather supplement and reinforce each other. Both volumes are well-illustrated with photographs and contain excellent bibliographies. Either as textbooks for college courses in the teaching of elementary science or as reference books for teachers in service, these two volumes will be of inestimable value.

ANNA E. BURGESS
Cleveland Public Schools
Elementary Science Editor

GENERAL CHEMISTRY FOR COLLEGES, Fourth Edition, by B. Smith Hopkins, *Professor of Inorganic Chemistry, Emeritus,* and John C. Bailar, Jr., *Professor of Chemistry, University of Illinois.* Cloth. Pages x+694. 16×23.5 cm. 1951. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $5.50.

This well known textbook for elementary college chemistry has been revised for the fourth time. In the first section of the book on general chemistry, a study of atomic structure is introduced early and this knowledge is used throughout the book. The periodic table is considered immediately following. This departure from customary general chemistry outline has the advantage of supplying the student with the periodic chart as a tool for the entire course in chemistry. The theory of ionization is not discussed in a separate section but instead the ideas of ionization are introduced and developed in discussion of atomic theory, solutions, and acids. There is likewise no chapter on chemical equilibrium as such, but the properties of an equilibrium reaction, the concepts of solubility product constant, and of ionization constant are introduced where they are needed and where they apply.

The second section of the book deals with inorganic chemistry. There is a chapter for each important family of elements and three chapters on carbon. The three chapters on carbon cover the organic chemistry usually included in general

chemistry courses, with a few paragraphs on petroleum and on application to medical products and foods. The concluding chapter on the chemistry of the nucleus is most interesting.

Each chapter is followed by a short set of exercises and problems and contains a very excellent and up to date bibliography for additional reading. The book is generously and interestingly illustrated.

The makeup of the book is unusual. Printing on the wide pages is displaced to leave a broad left margin while illustrations are set partially in the margins. There does not appear to be any advantage to this arrangement and certainly there is a disadvantage to numbering all pages on the left hand side.

The book deserves to be widely used for college chemistry courses.

LILLIAN HOAGLAND MEYER
Western Michigan College of Education

HIGH SCHOOL PHYSICS, by Oswald H. Blackwood, *Professor of Physics and Education, University of Pittsburgh;* Wilmer B. Herron, *Head of the Physics Department, Butler High School, Butler, Pa.;* and William C. Kelly, *Assistant Professor of Physics, University of Pittsburgh.* 671 pages. Ginn & Co. 1951. $3.76.

This is an excellent high school text giving in first-class exposition the standard gamut of physics at this level. It is simply but interestingly written, and the physics is eminently sound. The book possesses a goodly number of "teachable" features, such as solved problems, chapter summaries, topics for class discussion and self-tests. The drawings are especially good, many of them novel. Such diagrammatic representations possess excellent instructional value. The physics is up-to-date.

The book has an accompanying *Workbook and Laboratory Manual* which very ably supplements the text. The experiments are good. A *Teachers' Manual* is available offering suggestions for teaching, solutions for all the problems, lists of collateral books, lab equipment, etc.

High school teachers who see this book will have difficulty in putting it aside.

JULIUS SUMNER MILLER
Dillard University
New Orleans, Louisiana

FUNDAMENTALS OF PHYSICS, by Henry Semat, *Professor of Physics, the City College, College of the City of New York.* Revised Edition. 849 pages. Appendices. Rinehart and Co. 1951. $6.00.

This revised edition of Semat's college physics is enlarged and reorganized. Those who know Semat's earlier textbooks are aware of their excellence and they will be glad to have this "new" book. I am certain that this one will have a substantially larger adoption, to which it is altogether entitled.

The exposition is elegantly clear; the page format is appealing; the diagrams are very well done. The illustrative examples are good and the problems are more than adequate. The Questions at the end of each chapter are stimulating. The book is eminently teachable.

The obvious competition among textbook writers can make only for improvement. The Semat text is a case in point. It is beautifully done and I shall use it in the near future.

JULIUS SUMNER MILLER
Dillard University
New Orleans, Louisiana

HISTORY OF MATHEMATICS IN CARTOONS, by Mel Lieberstein. Pages 40 (unnumbered) 21.5×28 cm. Paper. Available from the author, 434 North Pearl Street, Lebanon, Illinois. Price $1.50.

This is a series of cartoons with approximately one-half page of typed comment

regarding the particular incidents. The items are arranged roughly in historical order, but each particular page is a unit in itself. The material would be probably quite valuable and interesting for display on a bulletin board. In general the content is historically accurate, although in a few cases this might be debatable; for example, the derivation of our word "algebra." The material is mimeographed on one side of the page only which makes it particularly adaptable to bulletin board display. In addition, many high school students would probably find the book an interesting one to browse through and in so doing they would acquire a considerable amount of historical information.

CECIL B. READ
University of Wichita

NUTRITION FOR HEALTH, by H. F. Kilander, *Specialist for Health Education, United States Office of Education.* Cloth. Pages xvi+415. 14×21 cm. 1951. First Edition. McGraw-Hill Book Company, Inc., New York. Price $3.00.

Nutrition is not a problem which we confront concurrently with famine. Nutrition is an everyday problem which we all face. Of the possible methods to better the nutrition of a people, educating them to recognize its values and needs is by far the most practical and lasting. That is the purpose of this book, which is designed for high school text usage or for supplementary reading.

Chapter 1 summarizes present-day knowledge of nutrition; Chapter 2 discusses the recommended daily dietary allowances of the National Research Council; and Chapter 3 tells some of the dietary deficiencies in the ordinary American diet. Chapters 4–9 consider the five major groups of nutrients: carbohydrates, fats, proteins, minerals, and vitamins. Chapter 10 gives details on the Basic Seven Food Groups introduced first in Chapter 3. In Chapter 11 the information presented previously is utilized in describing scientific meal planning. Chapters 12 and 13 describe the anatomical and physiological facts and mechanics of digestion. The last four chapters consider reducing and body weight, food conservation, food sanitation, and food laws, and superstitions and common misconceptions about food. At the end of each chapter there is a list of activities which he correlated with other courses as well as put to practical application in the home, in the school cafeterias, and in home-packed lunches.

Our food requirements have been altered greatly during the past quarter of a century as a result of new types of labor-saving machinery, but there has been a definite lag in the adjustment of our diets to meet these new needs. Nutrition is one of the most important of our world problems, and this timely book should serve us an important instrument of instruction in many classrooms.

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FOUNDATIONS OF BIOLOGY, Seventh Edition, by Lorande Loss Woodruff, *Late Colgate Professor of Protozoölogy, Director of the Osborn Zoölogical Laboratory, Yale University,* and George Alfred Baitsell, *Colgate Professor of Biology, Fellow of Calhoun College, Yale University.* Cloth. Pages xiv+719. 13.5×21 cm. 1951. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.50.

Those who know the past editions of this text will need no special introduction to the seventh edition. Professor Woodruff and the publishers asked Professor Baitsell, also of Yale University, to prepare this new edition. The result is a text of 35 chapters compared with the 29-chaptered previous edition.

Six chapters deal with material on reproduction while the "survey" chapters have been transferred to places near the end of the book. This new arrangement may make the text more suitable for use in a one-semester course, although it is well compiled to meet the needs of a year's course in general biology. It is possible that some persons would like to have seen more consolidation in certain

chapter areas. The quality of illustrations—an outstanding feature of past editions—has been enriched even more.

This text is bound to make new friends.

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A TEXTBOOK OF GEOLOGY, by Robert M. Garrels, *Northwestern University, Evanston, Illinois.* Cloth. Pages xvii+511. 15×23.5 cm. 1951. Harper and Brothers, 49 East 33d Street, New York 16, N. Y. Price $5.00.

This introductory text attempts to present a new analytical approach to the study of geology. It aims to emphasize the importance of reasoning rather than memorizing. It attempts the use of the scientific method; a method that is evolutionary, one that places emphasis on development and understanding rather than on description and memory. In attempting to carry out this plan the author has in many places fallen far short of his goal, but this is to be expected, for no one can be brought up on one method of living and then change immediately and completely to another. The text presents the important part of a very extensive subject in brief form, but all that is given is well stated, scientifically sound, and thoroughly illustrated by block diagrams, graphs, and pictures. The language used is carefully selected for presenting the subject to beginning students with simplicity and clarity. The text follows the usual plan and consists of three main divisions: first, the study of the surface of the earth and its continued modification by solar energy; second, a study of the internal energy of the earth and its effect on gradation and upheaval; and finally, the evolution of life and its development. To carry out a program of this type in a book of 500 pages demands that much be omitted but the author has made an excellent choice of his points for emphasis. It is a text very worthy of consideration.

G. W. W.

ARITHMETIC FOR COLLEGES, by Harold D. Larsen, Ph.D., *Professor of Mathematics, Albion College.* Cloth. Pages xi+275. 13×20.5 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.75.

This book has been written primarily for college students who are preparing to teach in the elementary school. Its purpose is to give these prospective teachers, who have had no contact with arithmetic as a fundamental subject since their elementary school days, a knowledge of the structure and techniques of arithmetic as well as an appreciation of its nature and significance. It differs from an arithmetic for children in that it is addressed to more mature minds and the fundamentals of arithmetic are treated from a somewhat advanced point of view. Many topics are included which are not found in the elementary textbooks.

A distinctive feature of this book is the chapter on approximate numbers and computation; this important topic has been treated at considerable length and the principles are presented carefully and clearly. A chapter on the slide rule introduces the student to this valuable tool for computation. Historical and recreational items are inserted frequently to add to the reader's interest and furnish valuable aids to the teachers of elementary arithmetic. There are excellent supplementary exercises at the end of each chapter. Each one of these directs the student to a reference where he may find the answer to the exercise or question. For example, such direct questions as "What is the best algorithm for short division?" and "Should long division be taught before short division?" suggest fruitful areas for investigation by the student.

Although this book was written for college students, it is this reviewer's opinion that experienced teachers would also find it interesting and a valuable aid in their work.

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